TM11-433

WAR DEPARTMENT TECHNICAL MANUAL

TIME CONTROL EQUIPMENT RC-133

WAR DEPARTMENT • *APRIL 1945*

TECHNICAL MANUAL

TIME CONTROL EQUIPMENT RC-133

CHANGE No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *13 April 1954*

TM 11-433, 30 April 1945, is changed as follows:

PART ONE

INTRODUCTION

Section 1. DESCRIPTION OF TIME CONTROL EQUIPMENT RC-133

Note. (Added) Line Connector Unit EE-87-A furnished on Order No. 2001-PHILA-50 is essentially the same as Line Connector Unit EE-87 covered in the basic manual except that capacitors, resistors, and transformers have been JANized and a 75-microfarad capacitor is used in place of the 100-microfarad capacitor. All information in TM 11-433 applies equally to Line Connector Unit EE-87-A unless otherwise specified herein.

Figure 28. The following note is added to the illustration:

Note. ON LINE CONNECTOR UNIT EE-87-A, A 75-MICROFARAD CAPACITOR REPLACES THE 100-MICROFARAD CAPACITOR SHOWN BY THE DOTTED LINES. IT IS CONNECTED IN SERIES WITH THE 45-OHM RESISTOR FROM THE NEGATIVE BINDING POST.

Figure 29. The following note is added to the illustration:

Note. ON LINE CONNECTOR UNIT EE-87-A, A 75-MICROFARAD CAPACITOR REPLACES THE 100-MICROFARAD CAPACITOR SHOWN BY THE DOTTED LINES. IT IS CONNECTED IN SERIES WITH THE 45-OHM RESISTOR FROM THE NEGATIVE BINDING POST.

45. Line Connector *Units* EE-87 *and* EE-87-A

* * * * * * *

i. Resistors.

(1) *Resistor RS-55.* Resistor RS-55 is * * * across the resistor. **All Line Connector Units EE-87-A include a 75-microfarad capacitor connected in series with this resistor from the negative binding post (fig. 29).** Take care in * * * nut and washers.

* * * * * * *

By order of the Secretary of the Army:

M. B. RIDGWAY,
General, United States Army,
Chief of Staff.

Official:

WM. E. BERGIN,
Major General, United States Army,
The Adjutant General.

Distribution:

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Tech Svc (1); Tech Svc Bd (1); AFF Bd (ea Svc Test Sec) (1); AFF (5); AA Comd (2); OS Maj Comd (5); Base Comd (5); MDW (2); Log Comd (5); A (5); CHQ (2); FT (2); Sch (5) except 11 (25); Gen Dep (2); Dep 11 (20) except Sig Sec, Gen Dep (10); Tng Div (2); POE (2), OS Sup Agency (2); Lab 11 (5); Mil Dist (1); Field Maint Shops 11 (3); T/O & E: 11-107, 11-127, 11-128A, 11-500A (GA-GP, KA, KB, KC), 11-587, 11-592, 11-597 (2).

NG: Same as Active Army except one copy to each unit.

USAR: None.

For explanation of distribution formula, see SR 310-90-1.

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WAR DEPARTMENT TECHNICAL MANUAL

TM 11–433

This manual supersedes so much of TM 11–433, Time Interval Apparatus EE–56, EE–85, EE–86–A, Line Connector Unit EE–87, Time Interval Signal BE–65, and Bell MC–153, 17 August 1942, as pertains to Time Interval Apparatus EE–85, Line Connector Unit EE–87, and Time Interval Signal BE–65. Remainder of TM 11–433, 17 August 1942, will be superseded by TM 11–445 (when published).

TIME CONTROL EQUIPMENT RC-133

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WAR DEPARTMENT

WASHINGTON 25, D. C., 30 April 1945.

TM 11–433, Time Control Equipment RC–133 is published for the information and guidance of all concerned.

[A. G. 300.7 (30 Jan. 45)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:

J. A. ULIO
Major General
The Adjutant General

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Refer to FM 21–6 for explanation of distribution formula.

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DESTRUCTION NOTICE

WHY —To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW —1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut—Use axes, handaxes, machetes.

3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives—Use firearms, grenades, TNT.

5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT—1. Smash—Cases, clock, interval mechanism, batteries, horn casting, phenolic and bakelite parts.

2. Cut—Wiring, coil winding, contact spring.

3. Burn—All wiring, technical manuals, wooden cases, other inflammable material.

4. Bend—Contact springs, drive rod, relay armatures, hummer springs.

5. Bury or scatter—All parts listed above.

DESTROY EVERYTHING

Figure 1. Time Control Equipment RC–133 in use.

This manual supersedes so much of TM 11–433, Time Interval Apparatus EE–56, EE–85, EE–86–A, Line Connector Unit EE–87, Time Interval Signal BE–65, and Bell MC–153, 17 August 1942, as pertain to Time Interval Apparatus EE–85, Line Connector Unit EE–87, and Time Interval Signal BE–65. Remainder of TM 11–433, 17 August 1942, will be superseded by TM 11–445 (when published).

PART ONE

INTRODUCTION

Section I. DESCRIPTION OF TIME CONTROL EQUIPMENT RC–133

1. General

a. Time Control Apparatus RC–133 is an equipment for producing audible signals from a horn or impressing tone on a telephone line at a regular and predetermined program of time intervals. This equipment consists of:

(1) Time Interval Apparatus EE–85 (figs. 3 and 4).

(2) Line Connector Unit EE–87 (figs. 8 and 9).

(3) Time Interval Signal BE–65 (figs. 11 and 12).

b. Time Interval Apparatus EE–85 is capable of producing electrical signal impulses at intervals of 1, 5, 10, 15, 20, 30, and 45 seconds, or any other desired time interval.

c. Line Connector Unit EE–87 produces a 1,000-cycle tone signal which is superimposed on telephone lines. The timing of the signal is controlled by Time Interval Apparatus EE–85.

d. Time Interval Signal BE–65 is a relay-operated local battery horn capable of delivering an audible signal which will carry over the background noise normally present in a mobile seacoast artillery battery.

2. Application

Time Control Equipment RC–133 is used to time accurately and in proper sequence all functions of fire control of mobile coast artillery installations. The equipment is completely portable and can be installed in a few minutes. Connection between the components of the equipment is made with field wire. A block diagram of a typical installation of Time Control Equipment RC–133 is shown in figure 2.

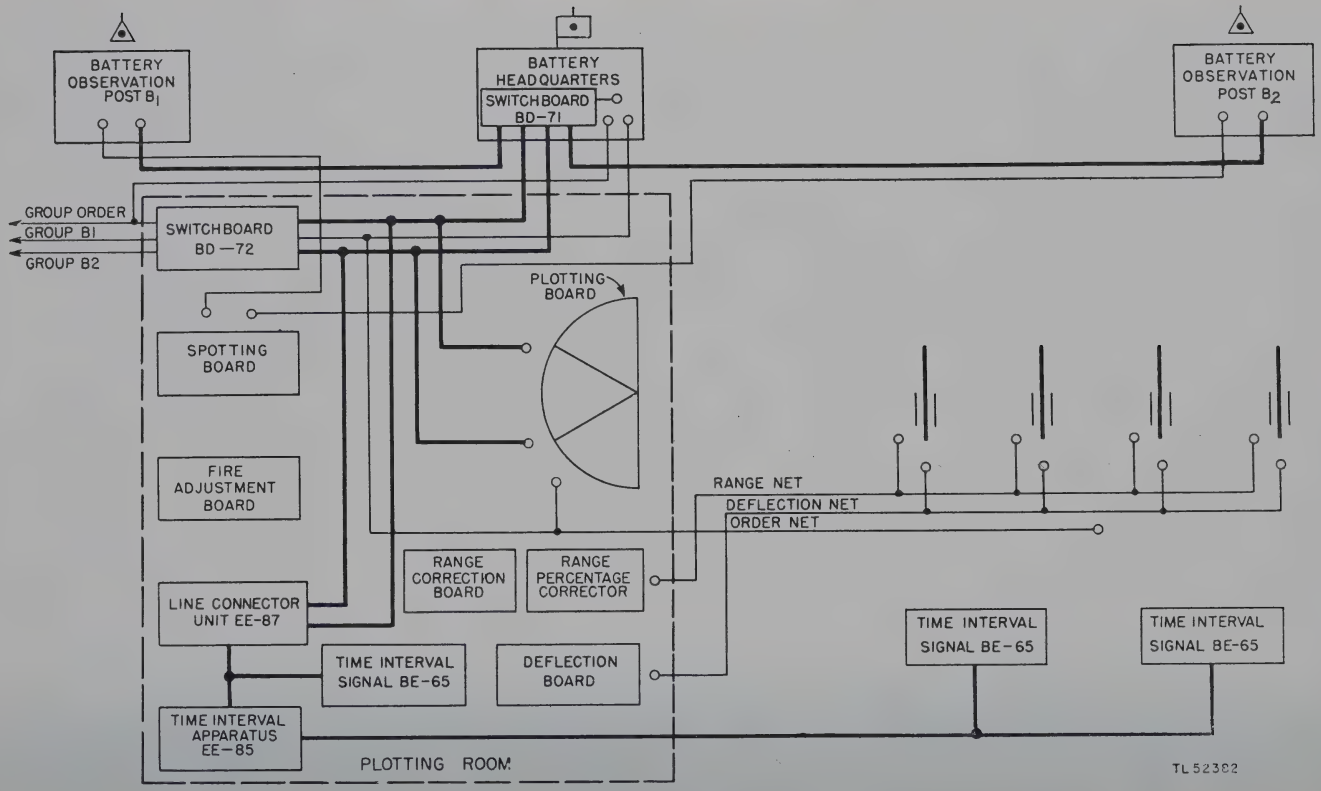

Figure 2. Typical installation of Time Control Equipment RC-133—Block diagram.

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3. List of Components

Note: This list is for general information only. See appropriate publications for information pertaining to requisition of spare parts.

Quantity	Component	Physical characteristics (unpacked)					Other characteristics
		Dimensions (in.)			Volume (cu. ft.)	Weight (lb.)	
		Length	Width	Height			
1	Time Interval Apparatus EE–85.	14¼	11¼	6⅞	0.64	14	Capacity — 16 lines, operates from 12-volt supply.
1	Line Connector Unit EE–87.	14¼	11¼	6⅞	0.64	25	Capacity—6 lines, operates from 12-volt supply.
5	Time Interval Signal BE–65.	10⅞	11½	6½	.47	18	Local battery horn relay operates on 12 volts, horn operates on 3 volts supplied from two internal Batteries BA–23.
10	Battery BA–23, Part of Time Interval Signal BE–65.	6½	2½	diam.	0.64	2	1½-volt cell.
4	Battery BB–55, 2 in use, 2 spare.	13	7	8¼	0.435	48	6-volt, 3-cell.
4	Terminal: battery; with wingnut; positive.	2⅜	⅞	1¼	0.01	0.5	
4	Terminal: battery; with wingnut; negative.	2-7/16	⅞	1¼	0.01	0.5	

4. Time Interval Apparatus EE–85

a. GENERAL. Time Interval Apparatus EE–85 is contained in a birchwood case with a hinged cover and a web carrying strap (fig. 3). A spring-hinged section on the left side of the cover provides an entrance for the field wire and battery leads. A spring hasp and catch are installed on the cover for securing the cover in place during operation and transportation. The case measures 6⅞ by 11¼ by 14¼ inches and completely assembled weighs 14 pounds. Two bakelite panels are mounted in the top of the case. The small panel holds the resonance clock, the heart of the fire control system; and the large panel holds the interval producing mechanism.

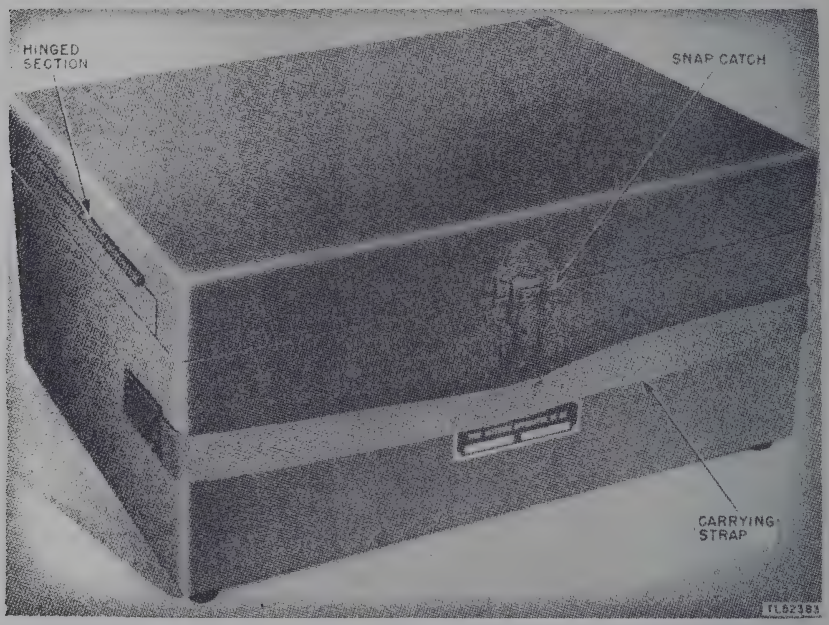

Figure 3. Time Interval Apparatus EE–85—cover closed.

b. SMALL PANEL (fig. 4). The small panel is held in place by six screws. A bakelite cylinder in which the clock is placed, is fitted into the center of the panel. The clock is held in place with two screws placed diametrically on the clock rim. The clock is equipped with three terminals for connection to the interval-producing unit.

c. LARGE PANEL (fig. 4). The large panel serves as a terminal board and a mounting for the interval-producing mechanism. The panel is held in place by four mounting screws placed along the top and bottom of the panel. The board is equipped as follows:

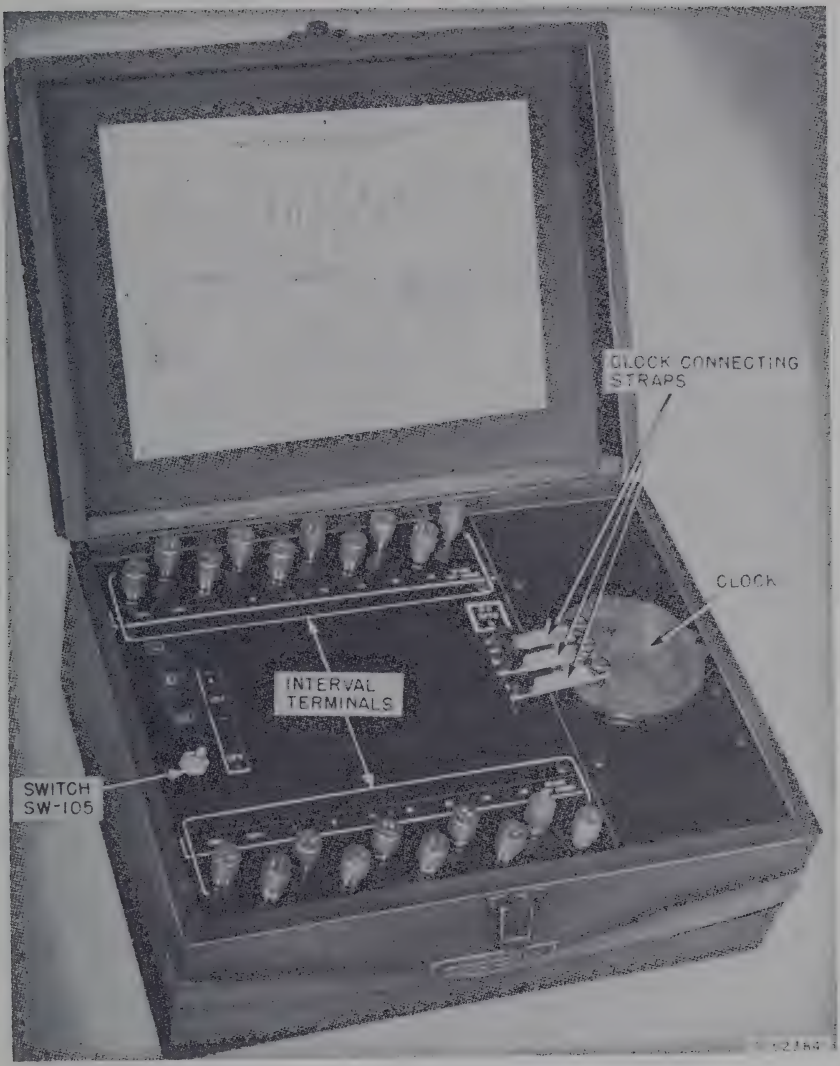

Figure 4. Time Interval Apparatus EE–85—cover open.

(1) Two Terminals TM–109 are placed on the left-hand side of the panel and are designated + and — 12 V. The battery leads are connected to these terminals.

(2) Switch SW–105 is installed on the left side of the panel and in front of Terminals TM–109. Only the OFF position is designated. This switch controls the power supplied to the unit.

(3) Three Terminals TM–152 are installed on the right side of the panel. These terminals have no designation and provide connection to the resonance clock by three brass straps.

(4) Twenty Terminals TM–195 are installed along the back and front of the panel. The front and back rows of terminals are designated as follows:

(*a*) Back row—COM, COM, 1, 5, 10, 15, 20, 30, 45, SPARE 120″ ARBOR.

(*b*) Front row—COM, COM, 1, 5, 10, 15, 20, 30, 45, SPARE 90″ ARBOR.

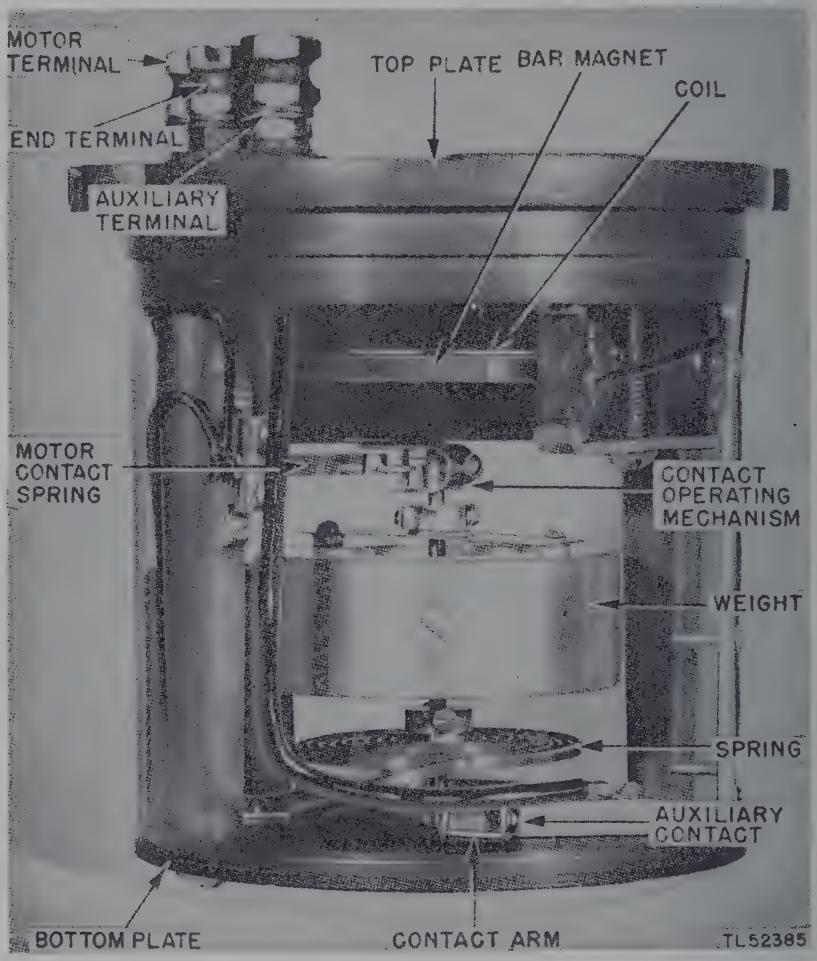

Figure 5. Resonance clock used in Time Interval Apparatus EE–85.

d. CLOCK (fig. 5). The clock mechanism is contained in a case consisting of a metal top plate, a bottom phenolic plate, two metal supporting bars, and a transparent plastic protecting cover. The mechanism consists of a pivot-supported axle upon which are

mounted a bar magnet, a contact-operating mechanism, a large cylindrical weight, and a spiral spring. The bar magnet is arranged so that it can rotate about the axle through a coil of wire. The contact-operating mechanism is arranged so that it makes a contact in the circuit of the coil at the instant the bar magnet swings into the coil. The spiral spring is attached to a contact arm so that an auxiliary contact will be made and broken during the rotation of the axle. When the clock is operating, the weight oscillates about its axle once every second. The period of oscillation is accurate within ± 2.88 minutes in 24 hours over the range of temperatures normally encountered in operation. The auxiliary contact is closed for 0.4 second during each 1-second oscillation. The leads to the coil and contacts are brought out to three terminals on the top plate of the clock unit. The front contact is connected to

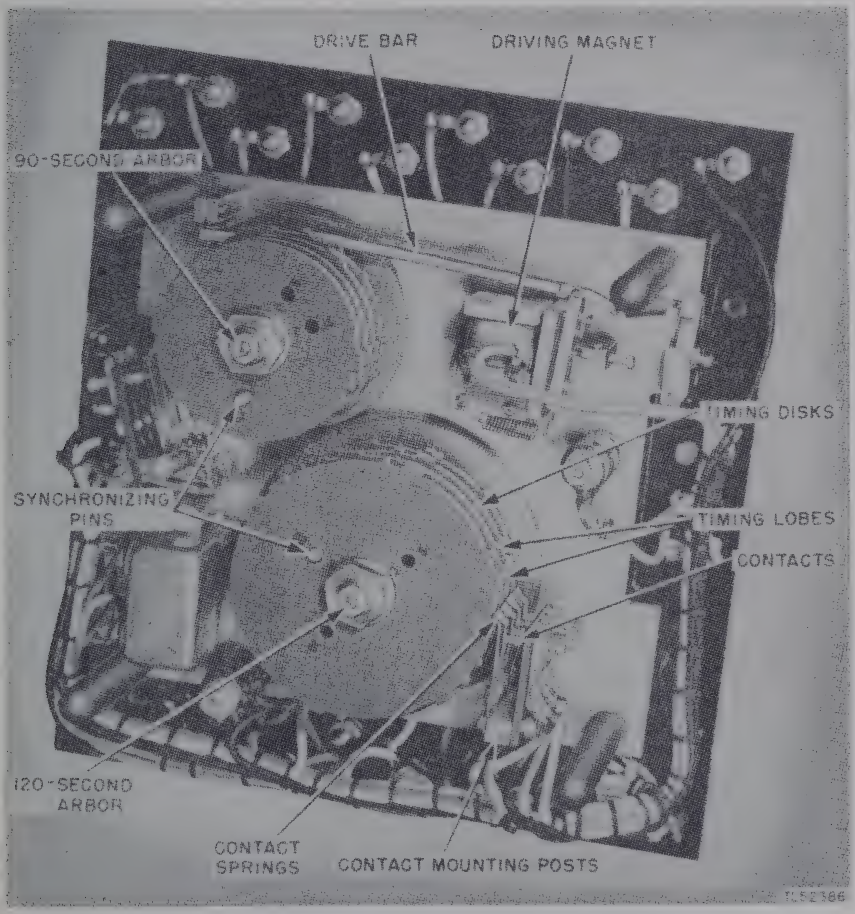

Figure 6. Interval mechanism in the Time Interval Apparatus EE–85.

the auxiliary contact; the center is marked GND and is common to both circuits, and the rear terminal is connected in the motor coil circuit.

e. DRIVING MECHANISM (fig. 6). The primary parts of the driving mechanism are a driving magnet, a drive bar, and a ratchet. The drive bar is actuated by the driving magnet and engages with the teeth of the ratchet. A drive bar tension spring is provided to return the drive bar to its unactuated position.

f. INTERVAL-PRODUCING MECHANISM (fig. 6). (1) *General.* The interval-producing mechanism includes two arbors, each of which has four timing disks and four associated contact assemblies.

(2) *Arbors.* One of the two arbors is designated as the 90-second arbor and the other is designated as the 120-second arbor. These designations denote the time required by each arbor to make a complete revolution. The 90-second arbor is driven by the action of the drive bar on the driving ratchet mounted near the base of the arbor. The 120-second arbor is driven by the 90-second arbor through two gears, one at the base of each arbor. In addition to the main arbor pin of each arbor assembly, there is a synchronizing pin projecting from each gear parallel to the arbor. The bakelite disks are drilled to fit on both the main arbor and the synchronizing pin.

(3) *Timing disks.* The timing disks are mounted on the arbor pins. Each arbor has four disks separated from each other by brass or phenolic spacers. The disks are made of a high strength phenolic material approximately $\frac{1}{8}$ inch in thickness. Each disk has a certain amount of the circumference cut down in such a manner as to leave several projecting rectangular timing lobes. The spacing of the lobes depends upon the desired time interval program and upon the particular arbor on which the disk is mounted. The disks on the 90-second arbor are, starting from the arbor base, arranged in the following order: 5-second, 15-second, 45-second, and spare. The 45-second disk has one second warning lobes spaced 5 seconds before the termination of the interval. The actual interval signal begins 3 seconds before the termination of the interval. To obtain delayed time interval programs instead of synchronized programs, holes are drilled at two positions other than the synchronized position on the spare disk. The hole for the synchronized position is marked S45 and the others are marked D5 and D15 to denote 5- and 15-second delays in the intervals from those in the synchronized position. On the 120-second arbor the disks are, starting from the arbor base, as follows: 10-second, 20-second, 30-second, and spare. The 20- and 30-second disks each have 1-second warning lobes spaced 5 seconds before the termina-

tion of the interval. The actual interval signal begins 3 seconds before the termination of the interval. The 10-, 20-, and 30-second disks are synchronized by the location of their synchronizing-pin holes and are marked S10, S20, and S30, respectively. Either of two disks is available for use as the fourth or spare disk. They are furnished with synchronizing-pin holes marked S20, D5, and D10 for one, and S30, D10, and D15 for the other. These disks pro-

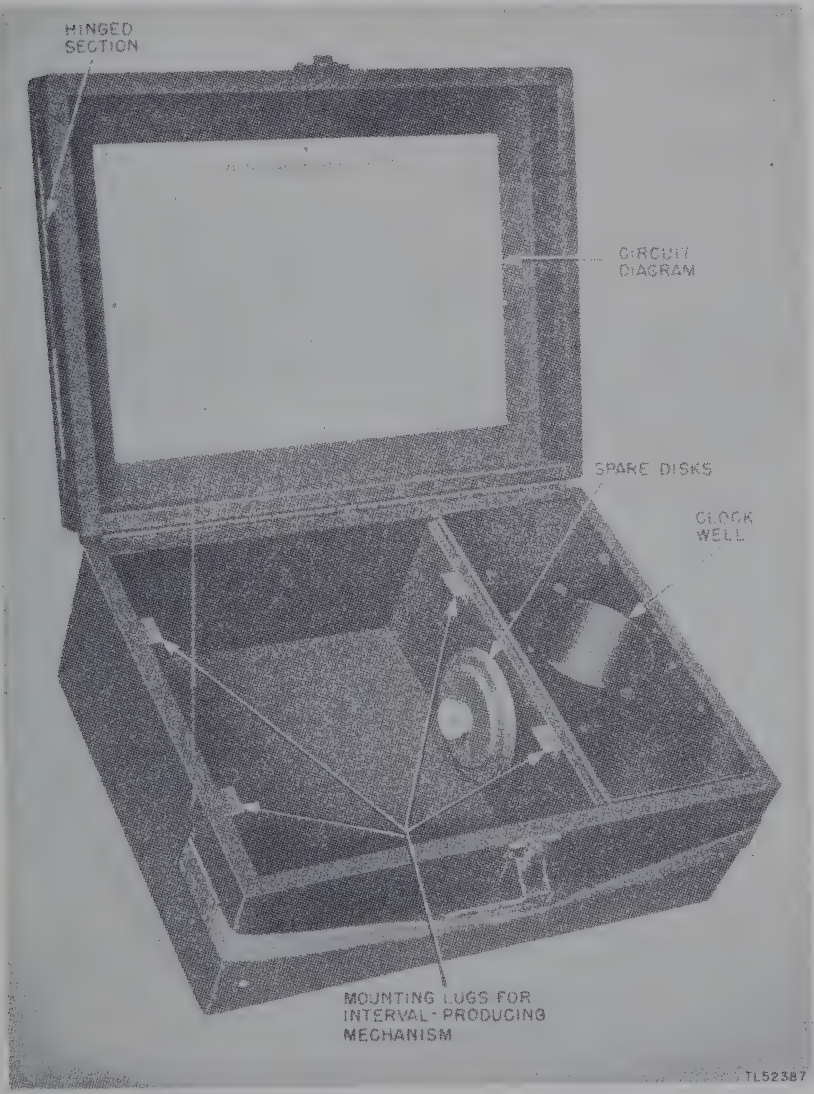

Figure 7. Time Interval Apparatus EE–85—cover open and mechcnism removed.

vide delayed 20- and 30-second intervals as indicated. One of these disks is carried on the 120-second arbor, and the other is mounted on a stud inside the case with two blank 90-second and two blank 120-second disks which may be cut for any desired intervals within the scope of their respective arbors (fig. 7).

(4) *Contacts.* The contact assemblies are mounted on brass mounting posts near the arbors. The contact springs are grounded through this mounting post, and the contacts are mounted on an insulating phenolic plate. The contacts are positioned so that they may be actuated by the timing lobes on the timing disks. Four contact assemblies are provided for each arbor.

5. Line Connector Unit EE–87

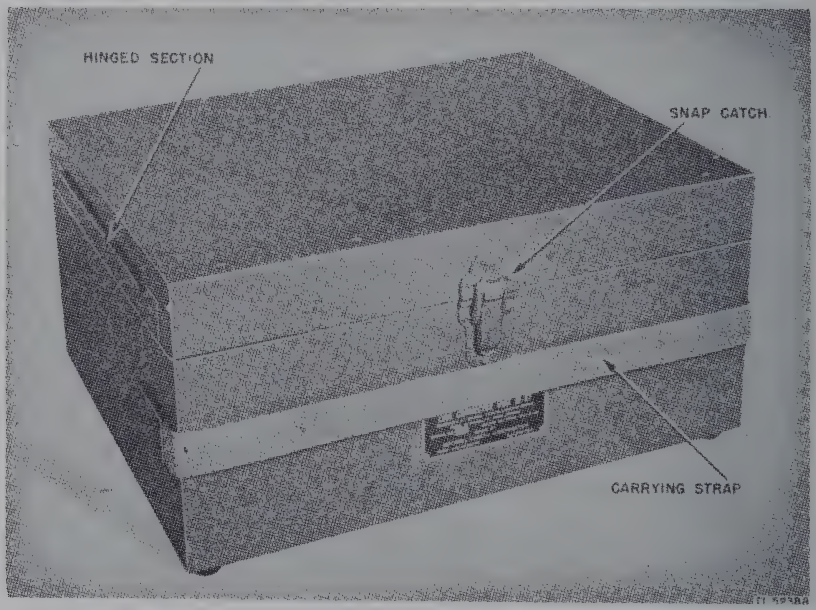

Figure 8. Line Connector Unit EE–87—cover closed.

a. CASE. Line Connector Unit EE–87 is contained in a birchwood case with a web carrying strap and hinged cover (fig. 8). The case is provided with a snap catch for securing the cover during operation and transportation. The case measures 11¼ by 14¼ by 6⅞ inches, and the assembled unit weighs 25 pounds.

b. PANEL (fig. 9). The panel of Line Connector Unit EE–87 is made of bakelite and holds the terminals for connection to the telephone lines, battery, and relay, and the keys for hummer selection and volume. The line terminals consist of 12 Terminals

TM–195 arranged in pairs along the front edge of the panel. The pairs of terminals are designated 1, 2, 3, 4, 5, and 6. The battery terminals are designated as + and — 12 VOLTS. Two Terminals TM–195 are designated RELAY and provide connection to the relay winding. The two lever-type keys are placed at the right side of the panel. The rear key is the hummer selector key and is designated INT. 1, OFF. and INT. 2. The front key is the volume key and is designated LOUD, MED., and LOW.

c. HUMMERS (fig. 10). The hummers are identical, when new, and consist of a tuned-reed vibrator and a carbon button microphone unit to pick up energy from the reed. The winding of the

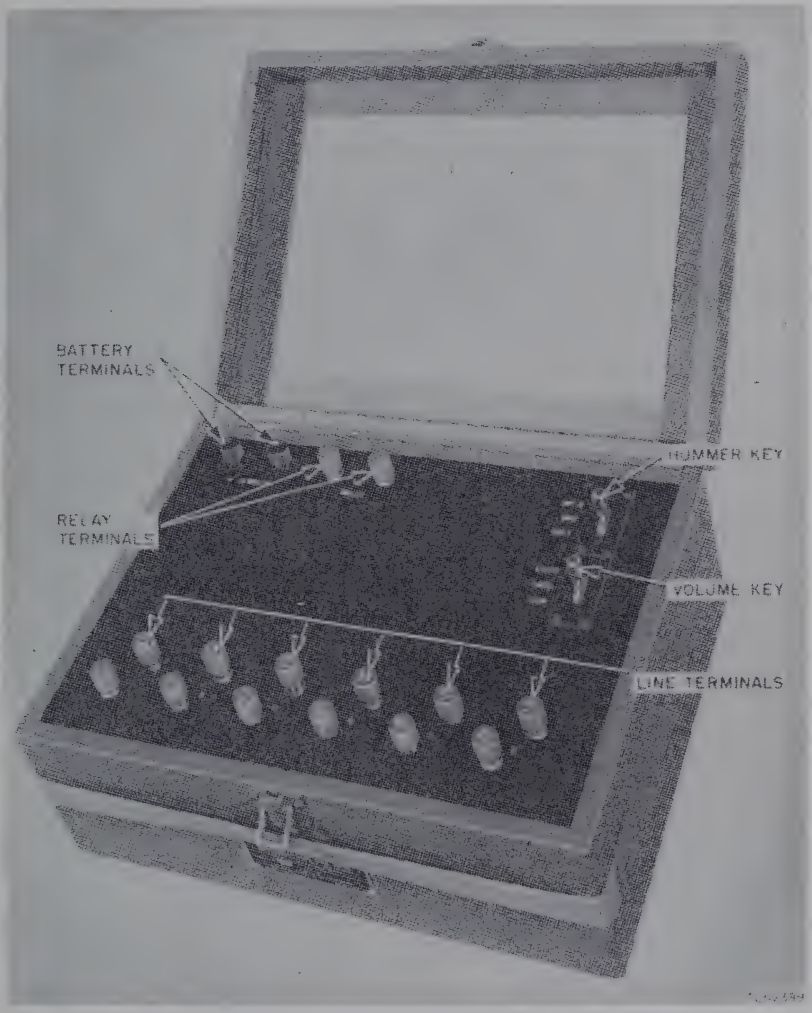

Figure 9. Line Connector Unit EE–87—cover open.

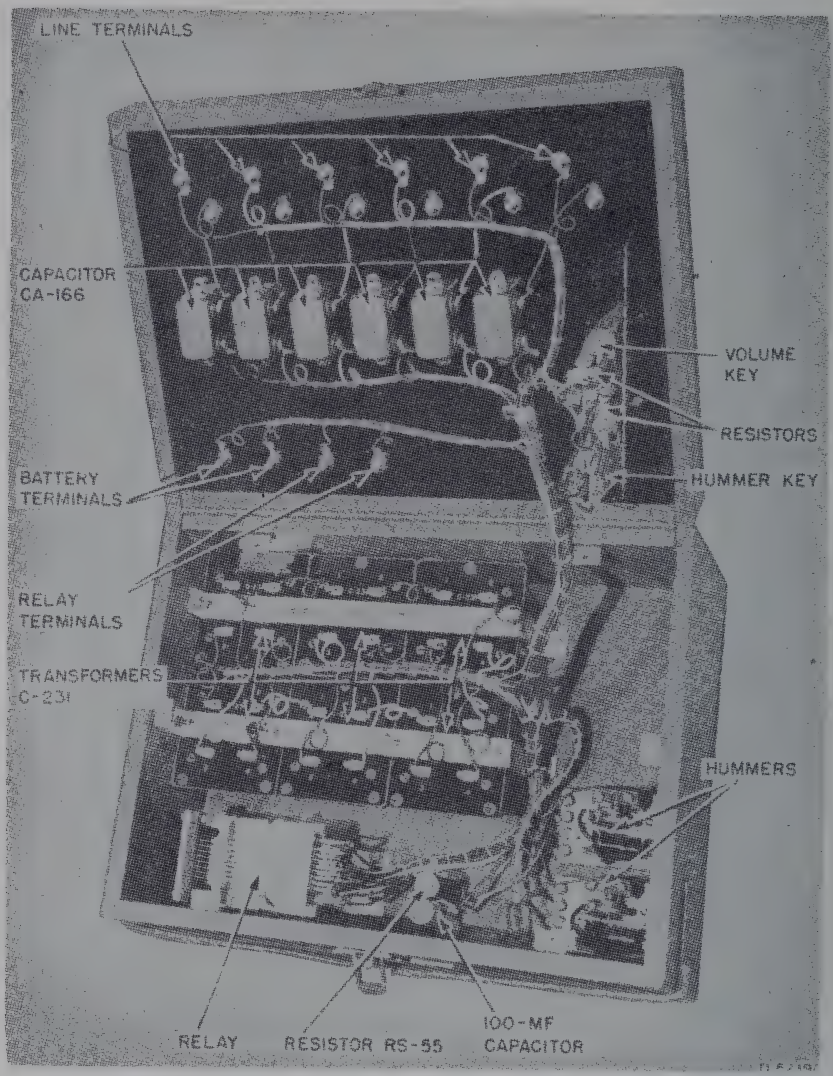

Figure 10. Mechanism of Line Connector Unit EE–87.

vibrator has a secondary winding associated with it for inductively coupling the output to the line circuit. A line-dropping resistor is connected in series with the hummer unit to limit the current in case of carbon freezing.

d. RELAY (fig. 10). The relay in Line Connector Unit EE–87 is a multiple-type relay. This relay has seven knife contacts. The moving contacts are mounted on flat springs, each of which is an integral part of the relay armature.

e. TRANSFORMERS C–231 (fig. 10). Transformers C–231 are contained in individual metal containers. Connection to the two windings is made by four terminal lugs on the top of the transformer case. Transformers C-231 are mounted in the line connector unit in two rows of three transformers. The transformers are held in place by a mounting strap across each row, and are further secured by two screws through the mounting strap into each transformer. There are 350 turns on the primary or hummer side of each transformer and 850 turns on the secondary or line side of each transformer, giving a turn ratio of 1 to 2.43.

f. CAPACITORS CA–166 (fig. 10). Capacitors CA–166 are 0.1-microfarad paper capacitors used in the line connector unit. They

Figure 11. Time Interval Signal BE–65.

are mounted on the bottom of the panel of the unit by means of mounting lugs at each end of the capacitor.

6. Time Interval Signal BE–65

a. CASE (fig. 11). The case of the time interval signal is made of sheet steel and measures 10⅞ by 11½ by 6½ inches. The case is equipped with a wire grill on the front, a carrying handle, and a hinged cover at the rear. A waterproof seal is installed on the side for entrance of the field wires from the plotting room. The case contains a relay, the horn mechanism, and batteries for operating the horn.

b. PANEL. (fig. 12.) A terminal panel is mounted inside the

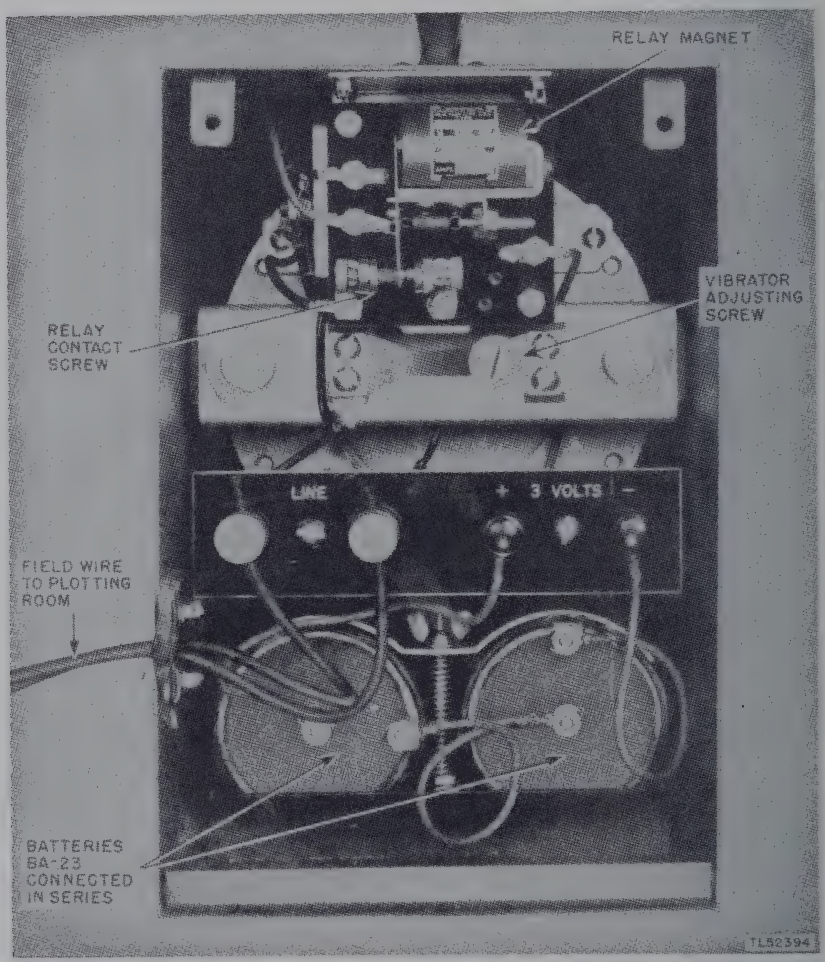

Figure 12. Time Interval Signal BE-65—rear view with cover open.

case at the rear near the hinged cover. This panel carries two Terminals TM–195 designated LINE, and two Terminals TM–109 designated + and — 3 VOLTS.

c. RELAY (fig. 12). The relay used in Time Interval Signal BE–65 is a high-resistance 1 make–1 break relay designed for operation on a minimum of 5.17-volt direct current. The winding is connected to the LINE terminals on the panel. The make contacts are connected in series with the batteries and horn magnet winding. The break contact is not used.

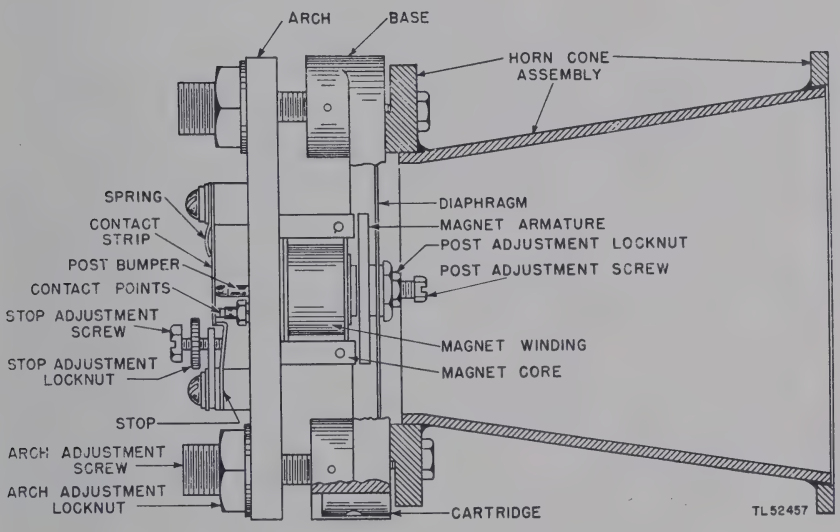

Figure 13. Time Interval Signal BE–65—cross section.

d. HORN (fig. 13). The unit of Time Interval Signal BE–65 is an interrupter-type for operation on 3 volts. The primary parts of the horn are the electromagnet, the armature, the post, the diaphragm, and the contacts. One end of the post is mechanically secured to the diaphragm. The other end is equipped with a rubber bumper which conveys the motion of the post to the contacts for interruption. The armature is mounted on the post in front of the electromagnet. A 6-mf capacitor is connected across the interrupter contacts.

7. Packing for Export

a. TIME INTERVAL APPARATUS EE–85. Time Interval Apparatus EE–85 is packed for export in a wooden box 20⅛ inches long, 16¾ inches wide, and 13¼ inches high (fig. 14). Two

metal straps are placed 3 inches from each end of the box for reinforcement purposes. See figure 15 for inside dimensions and packing details.

b. Line Connector Unit EE–87. Line Connector Unit EE–87 is packed for export in a wooden box identical to that used for packing Time Interval Apparatus EE–85.

c. Time Interval Signal BE–65. Time Interval Signal BE–65 is packed for export in a wooden box 16 inches long, 13⅛ inches

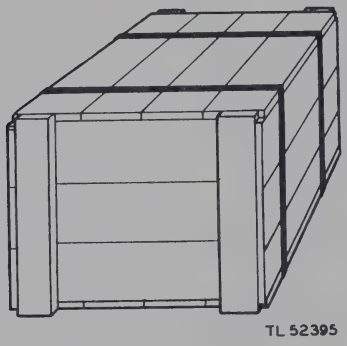

Figure 14. Time Interval Apparatus EE–85—packed for export.

wide, and 14¾ inches high. The box is of the same type as that used for packing Time Interval Apparatus EE–85 (fig 14). See figure 16 for inside dimensions and packing details.

Section II. INSTALLATION AND ASSEMBLY

8. Location of Equipment (figs. 1 and 2)

a. Time Interval Apparatus EE–85 is installed in a convenient and safe location in a tent, truck or other enclosure designated as the plotting room. The location should provide ready access to the terminal strip upon which the reader's telephone circuits are connected, and ample room for the associated equipment.

b. Line Connector Unit EE–87 is installed in the plotting room adjacent to Time Interval Apparatus EE–85. This location allows

easy connection to the time interval apparatus, battery, and line strips.

c. Time Interval Signals BE–65 are installed at gun positions and in the plotting room in a position where all signals will be easily heard by the firing crews of the guns and by the fire-control crews. There may be one Time Interval Signal BE–65 at each gun, one for two guns, etc., depending upon the distance between guns and the decision of the battery commander.

9. Unpacking, Uncrating, and Checking

Use particular care when unpacking or handling this equipment. The equipment may easily be damaged when not protected by the packing case. Do not apply pressure on the grillwork or other fragile exposed parts. Inspect the equipment for damage after removal from the packing case, and check the contents against the components parts list (par 3). Unpack the equipment in the following manner:

a. Place the packing case as near the operating location as possible.

b. Cut the steel straps (fig. 14).

Caution: Stand clear of the packing case when cutting the straps. Severe cuts or bruises may result from flying metal.

c. Remove the nails from the side and top of the packing box with a nail-puller. Remove the sides of the packing box.

Caution: Do not pry the sides off. Prying may result in damage to equipment.

d. Remove the top of the packing case and all the protective pads (figs. 15 and 16).

e. Remove the equipment from the packing case.

f. Remove the protective wrapping, and place equipment in its proper location.

Caution: When removing protective wrappings be careful not to damage the moistureproofing and fungiproofing coatings on the equipment.

10. Connections and Interconnections (fig. 17)

a. CONNECTIONS. (1) Both Time Interval Apparatus EE–85 and Line Connector Unit EE–87 are connected to the same 12-volt

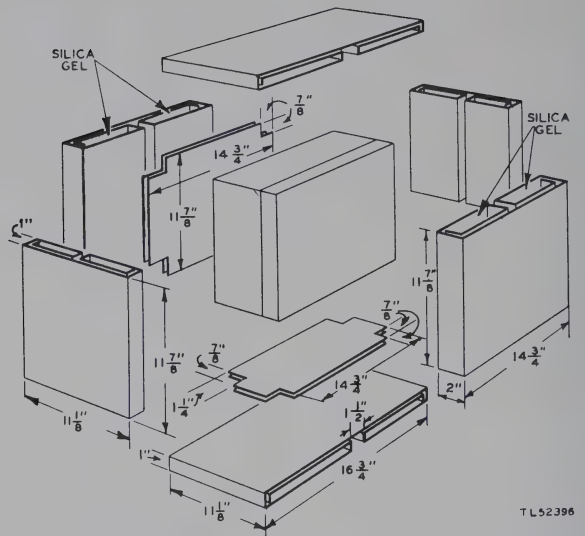

Figure 15. Unpacking Time Interval Apparatus EE–55.

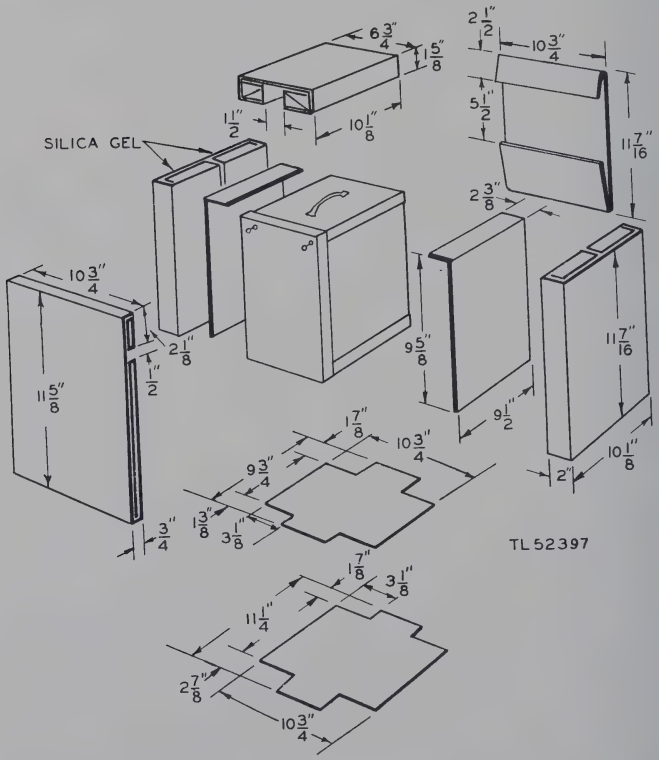

Figure 16. Unpacking Time Interval Signal BE–65.

Note: Batteries BB–55 will be unpacked, filled with electrolyte, and charged at depot prior to issue.

battery. Be sure that the positive and negative leads from the battery are connected to the proper terminals on the two equipments.

(2) Connect a wire to each of the RELAY terminals of Line Connector Unit EE–87. Attach one of the wires to a COM terminal of Time Interval Apparatus EE-85. Connect the other to the terminal for the interval program desired for observation.

(3) Connect one wire of each field wire pair from the guns to a COM terminal on the time interval apparatus. Connect the other wire to the terminal for the desired firing interval program.

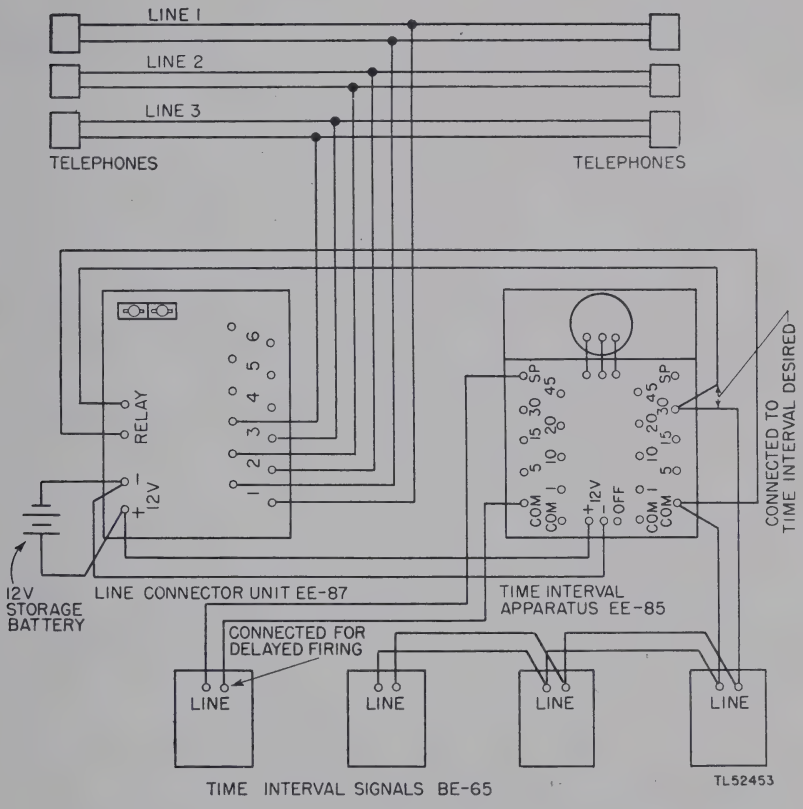

Figure 17. Cording diagram for Time Control Equipment RC–133.

(4) Connect the ends of the field wire from the line connector unit in the plotting room to the LINE terminals of Time Interval Signal BE–65.

(5) Insert two Batteries BA–23 in the battery cavity of Time

Interval Signal BE–65. Connect them in series and to the terminals designated + 3 VOLTS —. Make sure that the positive and negative terminal wires of the batteries are connected to the proper terminals on the panel.

b. INTERCONNECTIONS. To superimpose the 1,000-cycle tone on the telephone lines to the observers, connect two to six pairs of line terminals of Line Connector Unit EE–87 to the two armsetters' telephone lines, preferably at the terminal strip. Tone will be heard in all telephones because the readers', armsetters', and observers' telephones and headsets are all interconnected.

11. Preparation for Use

Time Control Equipment RC–133, including Time Interval Apparatus EE–85, Line Connector Unit EE–87, and Time Interval Signal BE-65, requires no preliminary adjustment.

12. Repacking Time Control Equipment RC–133 for Transport

a. TIME INTERVAL APPARATUS EE–85. Remove all wires from the terminals, clean excess dirt and other foreign matter from the panel, close the case, and snap the catch hasp.

b. LINE CONNECTOR UNIT EE–87. Remove all wires from the terminals, clean excess dirt and other foreign matter from the panel, close the case, and snap the catch hasp.

c. TIME INTERVAL SIGNAL BE–65. Remove the batteries from the battery compartment. Disconnect the field wire connections and remove the field wire. Clean all excess dirt and foreign matter from the case and mechanism. Close the cover and tighten the locking screws.

d. BATTERIES BB–55. Remove the cables from the batteries and clean the top surface of the battery. Make sure that all corrosion and other foreign matter is removed. The batteries are transported as received.

PART TWO

OPERATING INSTRUCTIONS

Note: For instructions on the destruction of this equipment to prevent enemy use, see the destruction notice at the beginning of the manual.

Section III. TECHNICAL OPERATION

13. Operating Instructions

a. Each gun battery of mobile artillery is responsible for the operation of its own Time Control Equipment RC–133.

b. Once all connections have been made to supply observing and firing interval signals as prescribed, no particular supervision is necessary other than to see that all equipment is functioning properly.

c. To start the equipment, throw the toggle switch on Time Interval Apparatus EE–85 to the *on* position. This starts the generation of time interval signals. It is possible for the rotating assembly of the clock to come to rest in a position where the circuit to the operating coils is open. If this should happen, the clock will not start when the switch of Time Interval Apparatus EE–85 is thrown to the *on* position. This condition can be corrected by lifting the entire Time Interval Apparatus EE–85 and rotating it sharply about one-quarter turn, keeping the panel horizontal. The inertia of the flywheel will cause it to start oscillating; the contacts will close at the proper time and the clock will pick up speed. Start the clock electrically after it has been placed in its operation position. If it does not start twist sharply as noted above. Once it has started electrically and is allowed to die down, it will start again by merely closing the starting switch.

d. Throw the starting key of Line Connector Unit EE–87 to either INT. 1 or to INT. 2. Either hummer will give signals of equal strength and clearness when new. After some use, it may be more desirable to use one hummer than the other. Adjust the volume of the hummer output by throwing the volume key to either LOUD, MED., or LOW.

e. If any change in either firing interval or observing interval is desired, change the wire from the interval signal or the line connector unit from one interval terminal to the new one. It is not necessary to change the COM connections of any wires; only the interval connections.

Caution: When equipment is operating, fasten all covers securely so that the several components will be protected from dust and moisture.

14. Equipment Performance Check List for Time Control Equipment RC–133

	Item No.	Item	Action or condition	Normal indication	Corrective measures
PREPARATORY	1	Time Interval Apparatus EE–85	Connect battery leads to battery terminals.		
	2	Line Connector Unit EE–87	Connect battery leads to battery terminals.		
	3	Time Interval Apparatus EE–85	Connect field wire to time interval terminals.		
	4	Line Connector Unit EE–87	Connect leads from Time Interval Apparatus EE–85 to RELAY terminals.		
	5	Line Connector Unit EE–87	Connect wires from terminal strips to line terminals.		
	6	Time Interval Signal BE–65	Connect field wire to LINE terminals.		
	7	Time Interval Signal BE–65	Insert and connect Batteries BA–23 in battery cavity.		
START	8	OFF switch	Throw to *on* position.	Audible click of driving magnet.	See paragraph 41.
	9	Hummer key	Throw to INT. 1 or INT. 2.	Audible hum of hummer unit.	See paragraph 42.
	10	Volume key	Throw to LOUD, MED., or LOW.	Volume of hummer unit.	See paragraph 42.
PERFORMANCE	11	Time Interval Signal BE–65	In operation.	Loud howl occurring at preset time interval.	See paragraph 43.
	12	Observers' telephones	In operation.	1,000-cycle tone heard on observers' telephone.	See paragraphs 40 and 42.
STOP	13	OFF switch	Throw to OFF.	Click of magnet ceases.	
	14	Hummer key	Throw to OFF.	Sound of hummer ceases.	

PART THREE

PREVENTIVE MAINTENANCE

Section IV. PREVENTIVE MAINTENANCE TECHNIQUES

15. Meaning of Preventive Maintenance

Preventive maintenance may be defined as a systematic series of operations performed periodically on equipment in order to maintain top efficiency in performance, to minimize unwanted interruptions in service, and to eliminate major break-downs. To appreciate the meaning of the term *preventive maintenance,* it is necessary to distinguish between preventive maintenance and trouble shooting and repair. The primary function of preventive maintenance is to prevent major break-downs and the consequent necessity for repair. In sharp contrast, the primary function of trouble shooting and repair is to locate and correct existing defects. The importance of preventive maintenance cannot be overemphasized. The usefulness of an entire fire-control system depends upon each piece of fire-control equipment in the system being ready to operate at peak efficiency when needed. Consequently, it is vitally important that operators and repairmen of fire-control equipment maintain their equipment properly.

16. Description of Preventive Maintenance Techniques

a. Most of the parts of this fire-control equipment require routine preventive maintenance. Those requiring maintenance differ in the amount and kind required. Because maintenance techniques cannot be applied indiscriminately, definite and specific instructions are needed. This section of the manual contains this type of specific instructions and serves as a guide for personnel assigned to perform the six basic maintenance operations, namely: FEEL, INSPECT, TIGHTEN, CLEAN, ADJUST, and LUBRICATE. Throughout this manual the lettering system for the six operations will be as follows:

F—Feel
I—Inspect
T—Tighten
C—Clean
A—Adjust
L—Lubricate

b. The first two operations establish the need for the other four. The selection of operations is based on a general knowledge of field needs. For example, the dust encountered on dirt roads during cross-country travel filters into the equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice all tend to cause deterioration of exposed surfaces and parts. Without frequent inspections and the necessary performance of tightening, cleaning, and lubricating operations, equipment becomes undependable and subject to break-down when it is most needed.

c. This section of the manual does not deal with individual parts of the equipment. Rather, it combines all instructional material on the major *classes* of parts. Section V treats the individual parts requiring maintenance.

d. The feel operation is used most often to check rotating parts, such as motor, arbors, and disks to determine if electrical connections, bushings, etc., are overheated. Feeling indicates the need for lubrication or the existence of similar types of defects requiring correction. The maintenance man must become familiar with the normal operating temperature of motors, etc., in order to recognize signs of overheating.

Note: It is important that the feel operation be performed as soon as possible after shut-down and always before any other is done

e. Inspection is the most important operation in the preventive maintenance program. A careless observer will overlook the evidence of minor trouble. Although these defects may not interfere with the performance of the equipment, valuable time and effort can be saved if they are corrected before they lead to major break-downs. Make every effort to become thoroughly familiar with the indications of normal functioning, in order to be able to recognize the signs of a defective set. Inspection consists of carefully observing all parts of the equipment, noticing their color, placement, state of cleanliness, etc. Inspect for the following conditions:

(1) Overheating as indicated by discoloration, blistering, or bulging of the parts or surface of the container; leakage of insulating compounds; and oxidation of metal surfaces.

(2) Placement, by observing that all leads and cabling are in their proper positions.

(3) Cleanliness, by carefully examining all recesses in the units for accumulation of dust, especially between connecting terminals. Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high-humidity locations, look for fungus growth and mildew.

(4) Tightness, by testing any connection or mounting which appears to be loose.

f. The tightening, cleaning, and adjusting operations are self-explanatory. Specific procedures to be followed in performing them are given wherever necessary throughout part three.

Caution: Screws, bolts, and nuts should be tightened carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

When a loose connection is tightened, it should be moisture-proofed and fungiproofed again by the application of varnish with a small brush. Refer to section VII for details of moisture-proofing and fungiproofing.

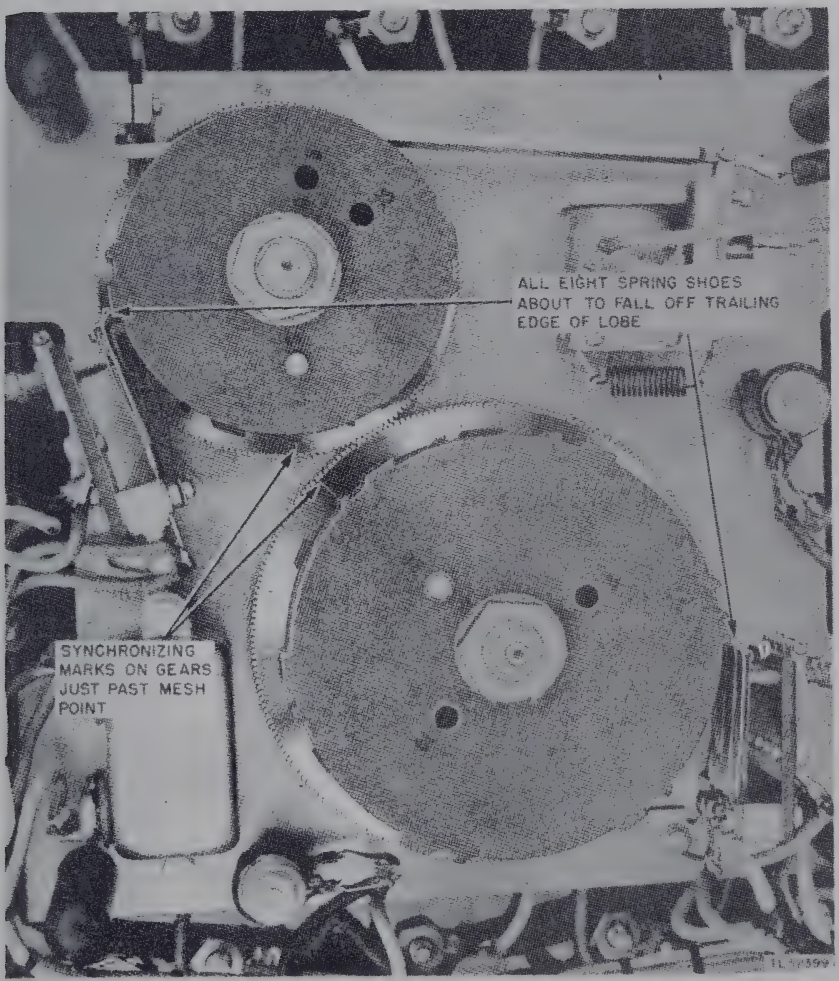

Figure 18. Synchronized position of arbors.

g. Lubrication refers to the application of grease or oil to bearings of motors or other rotating parts. Lubrication may also mean the application of a light oil to cover hinges or sliding surfaces on the equipment.

17. Clock

a. INSPECT. (1) Remove the clock from the panel by removing the two screws on the clock face, removing the brass connecting straps, and lifting the clock out of its well.

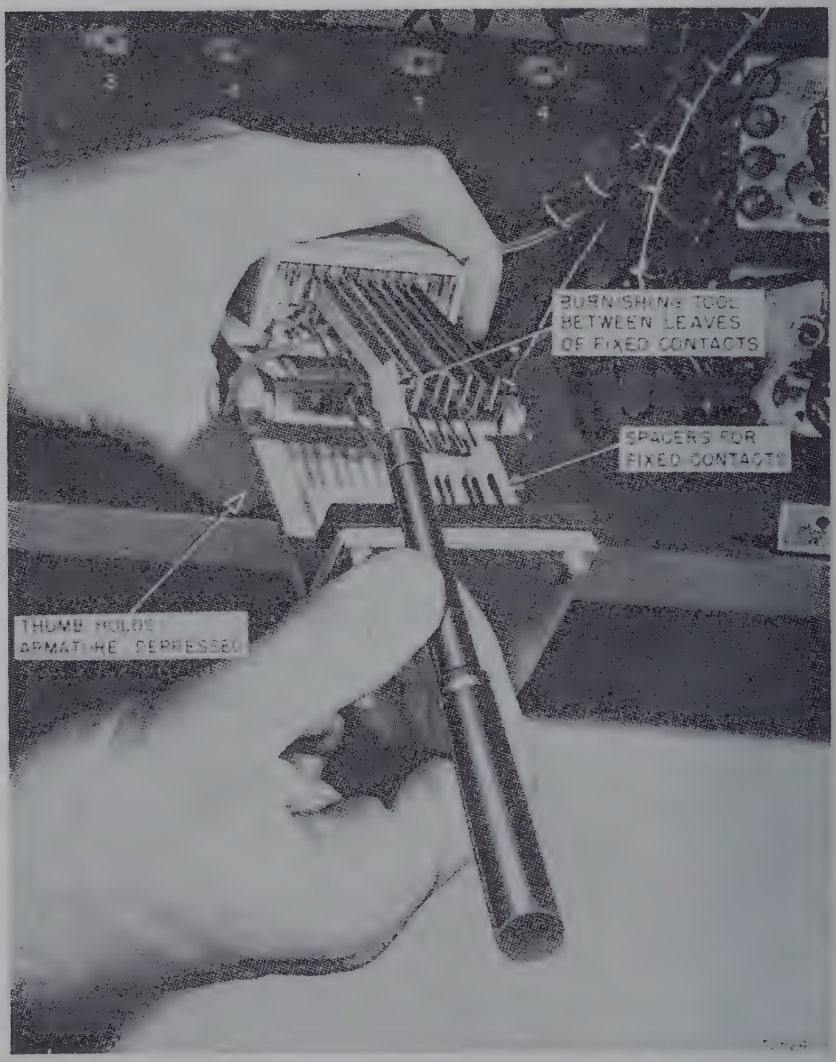

Figure 19. Cleaning line connector relay.

(2) Inspect the internal mechanism of the clock to see that it is in good working order. Rotate the clock to see that the weight oscillates freely, and that the contacts are making and breaking properly.

(3) Inspect the transparent plastic cover which protects the working parts of the clock. Check to see that it is not dented or torn.

(4) Inspect the top clock plate to make certain that it is not cracked.

(5) Inspect the terminals to see that the threads are not stripped or marred, or that the terminal nuts are not burred.

b. TIGHTEN. Tighten the screws on the clamping strip which holds the plastic cover.

c. CLEAN. Clean the plastic cover and the bottom plate if necessary. Remove all foreign matter from the top plate and terminals.

d. ADJUST. Adjust the thrust bearing setscrew on the bottom plate of the clock if the weight does not oscillate freely or tends to bind.

18. Panels

a. INSPECT. Inspect all terminals, switches, and keys for corrosion, marred threads, and loose parts.

b. TIGHTEN. Tighten all switches, terminal bolts, key mounting screws, and designation strip screws.

c. CLEAN. Clean all dirt, corrosion, and other foreign matter from the panel and the terminals.

d. LUBRICATE. Spread a thin film of oil over the cover hinge.

19. Interval Producing Mechanism of the Time Interval Apparatus EE–85

a. GENERAL. (1) *Inspect.* Inspect all connections to make certain that they are tight. Check the brass floor plate and the supporting posts to make sure that they are tight. Feel the cabling to make sure that it is firmly bound. Check the mounting of the resistors and capacitors to make sure that they are secure. Inspect the insulation of all wiring and make sure that no insulation is damaged or charred. Inspect the resistors and capacitors for signs of overheating or leakage of filling compound.

(2) *Tighten.* Tighten all loose screws and loose connections.

b. DRIVING MECHANISM (fig. 26). (1) *Inspect.* Inspect the magnet assembly (24) to see that there are no loose parts. Check the armature (23) for excessive side play. Operate the drive bar (17) by hand to make sure that the action of the bar is free and

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unimpeded. Check the drive bar for excessive play. When operating the drive bar by hand, make sure that the bar will return to the unoperated position freely, especially when several contacts are being actuated simultaneously. Inspect the magnet winding (24) for evidence of overheating or water-soaking. Check the position of the armature stop post (22). The armature arm (23) should come in contact with the armature stop post (22) at the instant that the ratchet pawl (7) engages with the teeth of the ratchet (1). Inspect the ratchet to see that all the teeth are in good condition. Inspect the ratchet assembly to see that the pawl edge is sharp and even, and that the entire assembly moves freely.

(2) *Tighten.* Tighten all loose screws except those used for making adjustments.

(3) *Clean.* Clean dirt and other foreign matter from all parts of the driving mechanism. Make sure that the ratchet and the space between the magnet and the armature are free from any deposit of foreign matter.

(4) *Adjust.* (*a*) Adjust the drive bar (17) by means of the drive-bar stop screw (2) so that the drive block (4) always engages a ratchet tooth when in the unoperated position.

(*b*) Adjust the armature stop screw (22) so that the armature arm just makes contact with the stop screw at the instant that the ratchet pawl engages with the next tooth of the ratchet.

(*c*) Operate the magnet armature (23) by hand. When the free end of the magnet armature (23) touches the drive magnet core (24), the edge of the drive-bar block (4) should just drop over another tooth of ratchet wheel (1) and should clear the flank of the adjacent tooth by approximately 0.005 inch. If it does not, adjust the swing of the drive magnet armature (23) by loosening the two armature arm screws (35) and turning the adjusting screw (37) so the edge of the drive-bar block (4) slips on the next tooth of the ratchet (1). Retighten screws (35) and check again. Adjust the spring tension adjusting screw (20) so the mechanism will overcome friction drag at the synchronized position.

c. Interval Mechanism (fig. 26). (1) *Inspect.* Inspect the contact mounting post (33) to see that it is securely fastened to the floor plate. Rotate the disk assembly to check for slipping of the ratchet. Feel the contact adjusting screws (29) to make sure that they are tight. Feel the contact springs (31) and make sure that they are tight. Make sure that the arbor disks are held tightly by the arbor post nuts (27). Inspect the arbor disks for cracks, breaks, and chips. Watch especially for chipped timing

lobes. Inspect the contact surfaces for burned or pitted areas. Inspect all threaded surfaces for marred threads. Inspect the gears to see that they mesh properly at all points. This check may be made by holding the ratchet bar in the operated position by hand and rotating the gears. Rotate the 120-second gear at least three times so that a check may be made on tooth engagement at all possible points of contact. Inspect the contact springs to see that they just touch the low portions of the timing disks. Check the clearance of the contact points. The contact clearance should be 0.040 inch.

(2) *Tighten.* Tighten all screws other than those used for making adjustments. Tighten the two nuts (27) at the top of each arbor post.

(3) *Clean.* Clean all dirt and other foreign matter from the entire assembly. Use a burnishing tool to clean the contact points.

(4) *Adjust.* (*a*) Loosen the locking screws in the contact pressure adjustment plates (34) and turn the contact mounting posts (33) with a wrench until the spring shoes no longer touch the disks. This can be done with an end wrench having a 5/16-inch opening. Adjust the mounting posts (33) so the tips of the spring shoes (5) and (28) barely touch the low portions of their respective disks. Lock this adjustment by means of locking screws on the pressure adjustment plates (34).

(*b*) Check the mating marks on gears to make sure that they coincide with each other (fig. 18). The two marks are coincident once in every four turns of the 90-second arbor and once in every three turns of the 120-second arbor. To match the mating marks, remove the small nut at the top of the arbor post, lift and rotate the assembly to the position where the mating marks will coincide. Make a further check on the synchronization of the gears by checking the position of the contact shoes when mating marks coincide. All eight contact shoes should be at the top of the main timing lobes just ready to fall off the edge of the lobes. If the contact shoes for both arbors are not in this position, lift one of the arbor assemblies and remesh the gears until the shoes are synchronized. This synchronizing point may separate the marks on the two gears by as much as five teeth.

(*c*) Adjust each of the fixed contact screws (29) so that the contact gap is approximately 0.04 inch when the contact spring shoes are on a low portion of the timing disks. Loosen the locking screw on the terminal strip before making the adjustment.

20. Line Connector Unit EE–87

a. GENERAL. (1) *Inspect.* Inspect all connections to make sure they are tight. Make sure that all the terminals are tight. Check

the mounting of the various components for tightness. Feel the cabling to be sure that it is secure. Inspect the insulation of all wiring and make sure that no insulation is damaged or charred. Inspect the resistors and capacitors for signs of overheating or leakage of filling compound.

(2) *Tighten.* Tighten all loose screws and loose connections.

(3) *Lubricate.* Lubricate the cover hinge with a light coat of oil.

b. Relay Assembly. (1) *Inspect.* Inspect the armature assembly to see that there is no side play. Check the mounting to see that it is secure. Remove the relay from the line connector unit case by unscrewing the four wood screws on the base. Inspect the contacts for burned areas. Check all soldered connections for tightness. Inspect the alignment of the contact springs. The movable contact should center between the two portions of the fixed contact spring when viewed from the top.

(2) *Tighten.* Tighten all soldered connections if necessary. Tighten all screws.

(3) *Clean.* Clean the body of the relay with a cloth or soft brush. Clean the contacts as follows (fig. 19) :

(*a*) Lift the relay out of the case. Take care not to strain or break the wires to the relay terminals.

(*b*) Turn the relay over and remove the two fillister-head steel screws which hold the contact assembly in place.

(*c*) Grasp the contact assembly by the steel arch which holds the phenolic spring spacers and rotate the whole assembly back and away from the floor plate of the relay. Pull the armature with the thumb and middle finger so the phosphor-bronze movable springs will spring away from the fixed springs.

(*d*) While the springs are in this position, clean all contact surfaces with a burnishing tool.

(*e*) Reassemble the contact spring assembly. Make sure that all metal spacers at the contact end of the relay are slipped between the two portions of each fixed spring.

(4) *Adjust.* Adjust the contacts as follows (fig. 20) :

(*a*) If the contacts are out of alignment, bend the metal spacers above the contacts so that the contact surfaces are lined up. This operation may be performed with long-nose pliers or with a spring-bending tool.

(*b*) If the travel of the fixed contact is over 1/32 inch, use a spring-bending tool or screwdriver to bow the spring downward between the armature strip and the phenolic spring supports.

(*c*) If the travel of the fixed contact is under 1/32 inch, bow the spring upward in the same manner.

c. KEYS. (1) *Inspect.* Inspect the key springs for tightness. Check the key handle to make sure that it is screwed on the key lever tightly. Feel the resistors to determine that they are se-

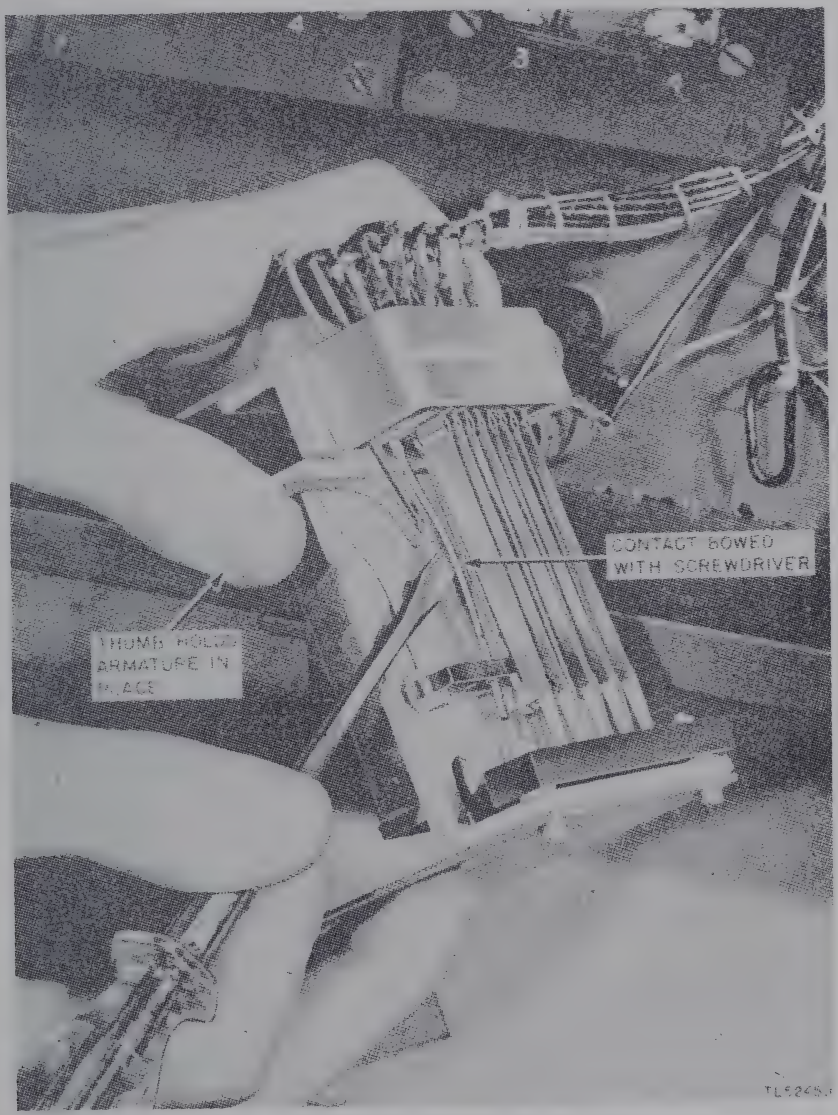

Figure 20. Adjusting line connector relay.

curely fastened to the terminal lugs of the keys. Inspect the key contacts to determine if they are burned or worn excessively. Inspect the resistors for signs of overheating or absorption of moisture. Check the spring contacts to see that they make and break in the proper sequence.

(2) *Tighten.* Tighten all screws and the phenolic handle on the lever. Tighten the soldered connections if necessary.

(3) *Adjust.* Adjust the contact springs so that each contact will have a clearance of 0.06 inch in the unoperated position.

d. HUMMERS. (1) *Inspect.* Remove the hummers from the case by unscrewing the two roundhead screws in the base of each hummer. Inspect the insulation of the hummer winding for breaks or signs of deterioration. Check the base for cracks resulting from tightening the mounting screws too tightly Feel the soldered connections to make sure they are firm.

(2) *Tighten.* Tighten the screws which hold the microphone button mounting post.

(3) *Clean.* Clean all surface dirt and dust from the unit.

(4) *Adjust.* If the unit requires adjustment, as determined from a weak signal, loosen the locknut on the pole-piece adjusting screw and set the screw for maximum volume. Make sure that the pole-piece and vibrating reed do not come in actual contact. Retighten the locknut and replace the units in the case.

e. TRANSFORMERS. (1) *Inspect.* Inspect the transformers for leaking compound, loose terminals, or cracked case covers. Check the mounting and cover screws for tightness.

(2) *Tighten.* Tighten all screws, both mounting and cover. Tighten the soldered connections if necessary.

(3) *Clean.* Clean all dirt from the transformer case and cover.

f. CAPACITORS. (1) *Inspect.* Inspect the capacitors for leaks of the compound. Check the terminals, terminal bushings, and soldered connections for tightness. Check the tightness of the mounting lugs.

(2) *Tighten.* Tighten the nuts holding the mounting lugs and the soldered connections, if necessary.

(3) *Clean.* Clean all dirt and other foreign matter from the surface of the capacitors.

21. Time Interval Signal BE–65

a. INSPECT. Inspect the relay armature to see that it is free to operate. Check the terminals to make sure that they do not bind. Check all connections and terminal screws to see that they are tight. Inspect the case for damage to the finish. Check the threads on the cover screws and mounting lugs for stripped or marred portions. Check the threads on the cover screws and mounting lugs for stripped or marred portions. Inspect the contact surfaces on the relay for pitted or burned areas. Inspect the wiring for abrasions or cuts in the insulation.

b. TIGHTEN. Tighten the relay terminal screws, all screws on

the outside surface of the case, and the screws which hold the vibrator assembly in place.

c. CLEAN. Clean the exterior of the case, and blow out the interior with compressed air. Remove all corrosion or other for-

Figure 21. Adjusting horn contacts.

eign matter from the battery compartment. Clean the contacts with a burnishing tool.

d. ADJUST. (1) Adjust the relay contacts to a clearance of 0.02 inch.

(2) Adjust the vibrator contacts as follows:

(*a*) Remove the screen grill from the front of the cone. Loosen the two locking nuts next to the head of the post adjustment screw (inside the cone) just enough to permit the post adjustment screw to be turned. Turn the post adjustment screw in a counterclockwise direction for about one turn.

(*b*) Loosen the locknut on the hexagonal-head stop adjustment screw on the arch assembly. Leave the + 3 VOLTS connection in place. Insert a screwdriver into the slot of the stop adjustment

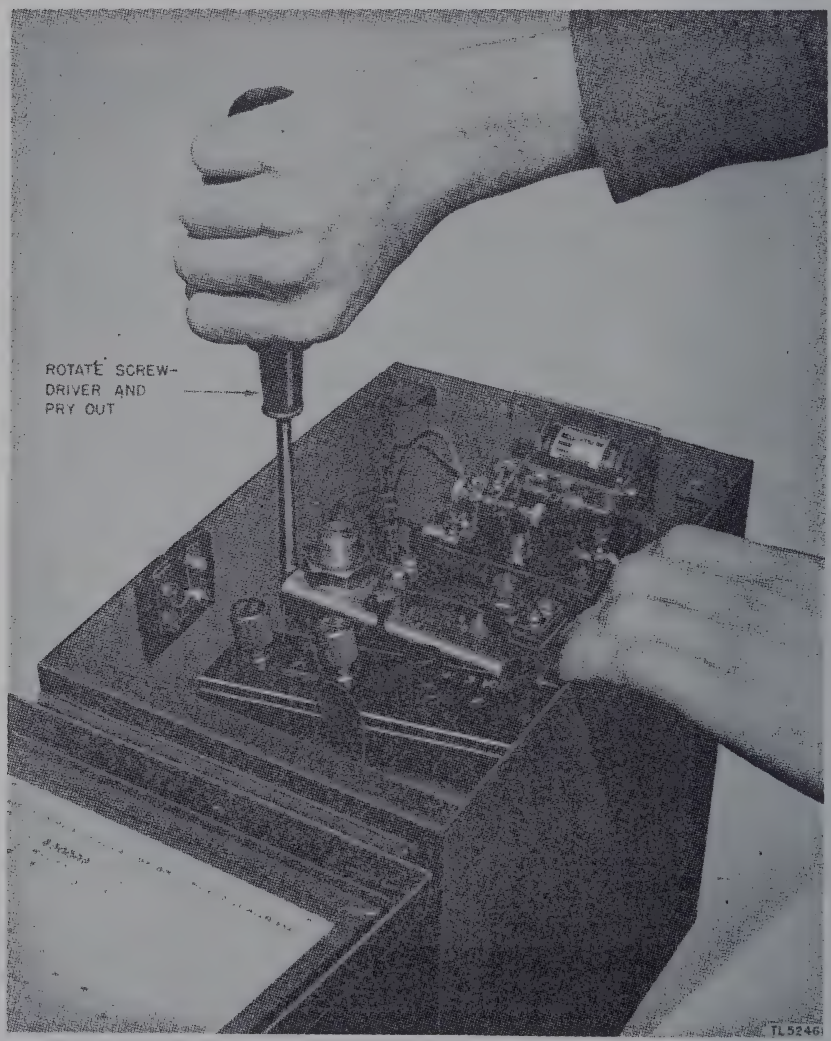

Figure 22. Removing horn from case.

screw. Make and break a connection to the metal portion of the screwdriver by intermittently touching the screwdriver with the 3 VOLTS — lead (fig. 21). A *plunk* should be heard each time the connection is made and broken. Turn the screw clockwise slowly until the plunk can no longer be heard. Then back the screw out just enough to let the horn plunk when the connection is made to the screwdriver. At this point, hold the stop adjustment screw in place with the screwdriver and tighten the locknut with a wrench.

(*c*) Turn the post adjustment screw clockwise (from the open

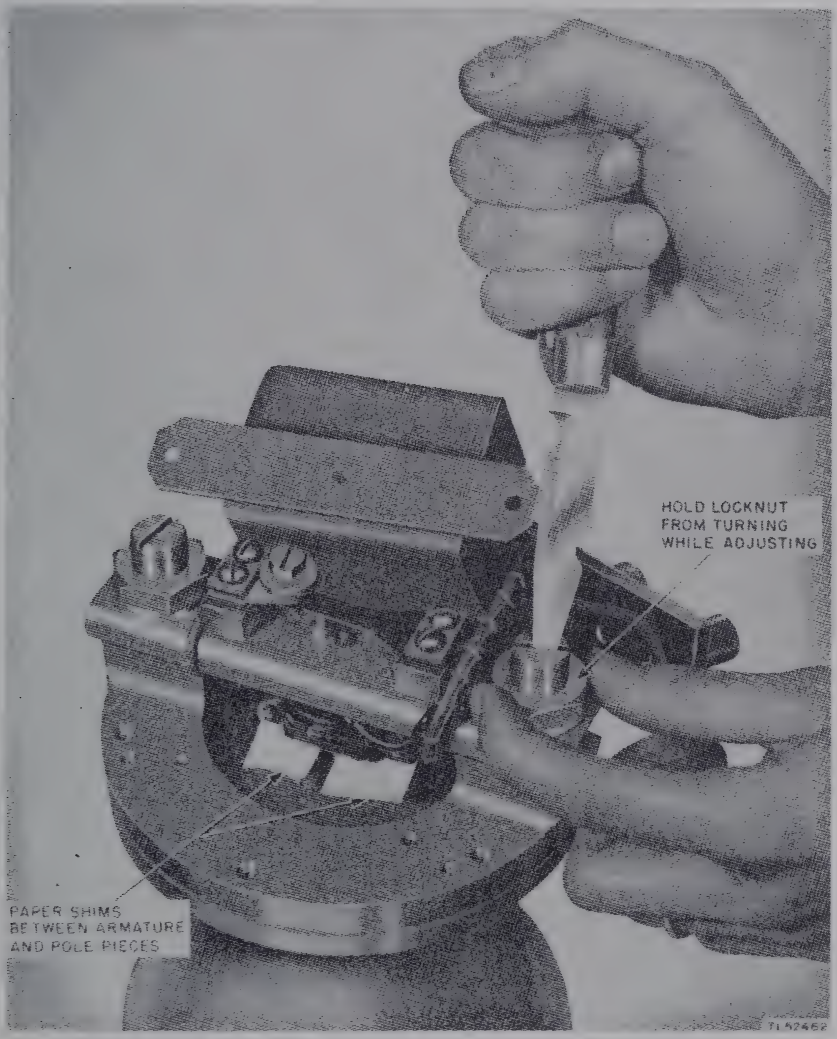

Figure 23. Adjusting armature gap on horn.

end of the horn) until the horn will blow when the 3-volt negative battery lead is touched to a grounded part of the assembly. Continue to turn the post adjustment screw clockwise until the pitch of the sound becomes higher. Then back the post adjustment screw out until the tone becomes hoarse, and the horn has a tendency to rattle. Turn the post in again very slowly until the hoarseness and tendency to rattle disappears. This is a critical adjustment and the screw should be turned only a few degrees at a time when approaching the final position. Lock the post adjustment screw by tightening the two locknuts.

(3) If the above procedures do not result in a satisfactory adjustment), it may be necessary to readjust the gap between the armature and the magnet faces as follows:

(*a*) Remove the horn assembly from the case by removing the four screws which hold the front of the cone, the two nuts which hold the relay on its support, and the two screws which pass through the side of the case into the horn assembly (fig. 22). The horn assembly can then be withdrawn from the box.

(*b*) Loosen the locknuts on the large arch adjustment screws at the end of the arch assembly just enough to allow these screws to be turned out but not enough to let the arch become loose.

(*c*) Back the post adjustment screw out at least two turns ((2) (a) above). Adjust the gap between the armature and the magnet faces to 0.018 inch by turning the arch adjustment screws (fig. 23). The gap itself is not critical and may be between 0.012 and 0.018 inch, but it is important that the gap be exactly the same (within 0.001 inch) on both ends of the armature.

(*d*) If feeler gauges are not available, a satisfactory adjustment can be made by using a piece of bond paper 0.003 inch or 0.004 inch thick as a feeler gauge. Turn the arch adjustment screws in until the armature and magnet face barely touch the opposite sides of the paper inserted at either end of the gap. Then turn each of the arch adjustment screws counterclockwise exactly one-third turn. This will add 0.010 inch to the gap. Hold the arch adjustment screws with a screwdriver while the locknuts are being tightened.

(*e*) Readjust the equipment as described in (2) (*c*) and (*d*) above. Reinstall the horn assembly and relay in the box, and check the final adjustment again ((2) (*d*) above) before returning it to service.

Section V. ITEMIZED PREVENTIVE MAINTENANCE

22. Common Materials Needed

Caution: The materials listed below must be at hand before performing preventive maintenance.

The following materials are used in performing preventive maintenance on this equipment:

a. Tool, Switchboard Contact Burnisher (6R41065C).
b. Clean cloth.
c. Common hand tools (Tool Equipment TE–47 or equivalent).

23. Daily Items

a. ITEM 1. EXTERIOR OF TIME INTERVAL APPARATUS EE–85.

OPERATIONS:

ITC	Case
ITC	Panels
ITCL	Hinges
IC	Terminals
ITC	Switch
ITC	Clock connecting straps

Note: If any terminal posts are loose, remove the panel and tighten the post by the nut at the bottom. Tighten the switch by twisting the hexagonal locknut on the switch shank.

b. ITEM 2. EXTERIOR OF LINE CONNECTOR UNIT EE–87.

OPERATIONS:

ITC	Case
ITC	Panels
ITCL	Hinges
IC	Terminals
ITC	Keys

Note: If any terminal posts are loose, remove the panel and tighten the post by the nut at the bottom. When checking the keys, make sure that the bakelite key handle is firmly screwed in place.

c. ITEM 3. TIME INTERVAL SIGNAL BE–65.

OPERATIONS:

ITC	Case
ITCL	Hinges
IC	Battery compartment
IC	Terminals
IC	Inside of case

Note: Blow out inside of case with compressed air to remove all accumulated dust. Tighten battery connections.

d. ITEM 4. BATTERIES BB–55.
OPERATIONS:

I	Specific gravity of electrolyte
IC	Case
ITC	Connectors and terminals
I	Electrolyte level

Note: Keep a record of the specific gravity of the battery electrolyte. Remove corrosion and dirt from the top of the battery and the connectors with a brush and clear water. In cases of excessive corrosion, add 2 ounces of ammonia water (stock No. 6G21) to each quart of cleaning water.

24. Fifty-six Operating Hours

a. ITEM 5. BATTERIES BA–23.
OPERATIONS:

I	Closed circuit voltage
I	Case
ITC	Terminals

Note: Replace the batteries if the closed circuit voltage is below 1.35 volts, or if the battery case shows any indication of electrolyte leakage. If difficulty is experienced in removing the batteries from the battery compartment, remove the terminal panel and lift the batteries out.

b. ITEM 6. CLOCK.
OPERATIONS:

IA	Accuracy
I	Contacts
ITC	Cover
IC	Terminals
IC	Top and bottom plates

Note: Do not remove the transparent cover from the clock frame. Examine the contacts carefully for burned or pitted areas. Check the accuracy of the clock over a period of 2 hours. This may be done by connecting a time interval signal to the 30-second interval terminal and starting the timing period on a 30-second signal. If the signal sounds exactly at the end of the timing period, the clock is accurate.

c. ITEM 7. HUMMERS.
OPERATIONS:

ITC	Base
ITCA	Hummer unit
ITC	Terminals

Note: During the maintenance operation, tap the carbon element to loosen any carbon that has become packed or *frozen.*

25. Two Hundred Fifty-six Operating Hours

a. Item 8. Interval Mechanism of Time Interval Apparatus EE–85

OPERATIONS:

ITC	All connections
I	Wiring
ITCA	Driving mechanism
ITCA	Contact assembly
ICA	Contacts
ITC	Capacitors
ITC	Resistors

Note: Mesh the gears at the mating marks and check to see that the shoes of all eight contact springs drop off the lobes simultaneously. If not, remesh the gears. When adjusting the contacts, the small adjusting screw on the terminal strip must first be loosened. Take care not to strip the threads on this screw.

b. Item 9. Line Connector Mechanism.

OPERATIONS:

ITC	All connections
I	Wiring
ITCA	Hummers
ITC	Transformers
ITC	Capacitors
ITCA	Key assemblies
ITCA	Relay
ITC	Resistors

Note: Make sure that the transformer mounting and associated screws are tight. Clean relay and key contacts with a piece of rough paper or with a burnishing tool. If any relay contact springs are bent or out of line, straighten them with long nose pliers or with a spring bender.

c. Item 10. Horn Mechanism of Time Interval Signal BE–65.

OPERATIONS:

I	Wiring
ICA	Relay contacts
ICA	Post contacts
ITC	All mounting and terminal screws
IC	Terminals

Note: Do not remove the horn mechanism from the case unless it is necessary to adjust the armature clearance. If some difficulty is experienced in removing the horn mechanism from the case, use a long screwdriver as a wedge to spring apart the two sides of the case. The horn will lift out easily once the case is sprung.

26. Preventive Maintenance Check List

The check list below is a summary of the preventive maintenance to be performed on Time Control Equipment RC–133. The suggested time intervals for performing the preventive maintenance as shown on the check list may be varied at any time by the local commander. However, for best performance of the equipment, it is recommended that the operations be performed at least as frequently as called for in the check list. The echelon column indicates which operations are considered first echelon maintenance and which items are considered second echelon maintenance.

Item No.	Operations	Item description	When performed					
			Daily	56 operating hours	256 operating hours	Every 6 months	Yearly	Ech.
1	ITCL	Exterior of Time Interval Apparatus EE–85	X					1st
2	ITCL	Exterior of Line Connector Unit EE–87	X					1st
3	ITCL	Exterior of Time Interval Signal BE–65	X					1st
4	ITC	Batteries BB–55	X					1st
5	ITC	Batteries BA–23		X				1st
6	ITC	Clock		X				2d
7	ITCA	Hummers		X				2d
8	ITCA	Interval mechanism			X			2d
9	ITCA	Line connector mechanism			X			2d
10	ITCA	Horn mechanism			X			2d

F Feel I Inspect T Tighten C Clean A Adjust L Lubricate

Section VI. LUBRICATION

Note: A War Department Lubrication Order is not issued on Time Control Equipment RC–133. See section IV for lubrication instructions for this equipment.

Section VII. MOISTUREPROOFING AND FUNGIPROOFING

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27. Problems Encountered

The operation of Signal Corps equipment in tropical areas where temperature and relative humidity are extremely high requires special attention. The following items represent problems which may be encountered in operation.

a. Resistors, capacitors, coils, chokes, transformer windings, etc., fail.

b. Electrolytic action takes place in resistors, coils, chokes, transformer windings, etc., causing eventual break-down.

c. Hook-up wire and cable insulation break-down. Fungus growth accelerates deterioration.

d. Moisture forms electrical leakage paths on terminal boards and insulating strips.

28. Treatment

A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. Refer to TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing, and the supplies and equipment required in this treatment.

Caution: Varnish spray may have toxic effects if inhaled. To avoid inhaling sprays, use a respirator if available; otherwise, fasten cheesecloth or other cloth material over nose and mouth.

29. Step-by-step Instructions for Treating Time Interval Apparatus EE–85

a. PREPARATION. Make all repairs and adjustments necessary for proper operation of the equipment.

b. DISASSEMBLY. (1) Operate latch and raise cover.

(2) Remove straps between binding posts and clock.

(3) Remove four screws from the left-hand panel and lift out of case.

(4) Do *not* remove clock unit.

(5) Expose underside of panel.

(6) Remove four supports and raise apparatus mounting plate.

(7) Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment to be processed.

c. MASKING. Masking of this equipment is not required.

d. DRYING. Place equipment in oven or under heat lamps and dry for 2 to 3 hours at 160°F.

e. VARNISHING. Apply three coats of moistureproofing and fungiproofing varnish (Lacquer, Fungus-resistant, Spec. No. 71–2202 (stock No. 6G1005.3), or equal) to the following parts:

(1) Brush all wiring and soldered connections on underside of panel and plate.

(2) Brush capacitor, switch, wiring and soldered connections on mounting plate.

(3) Varnish edges of phenolic panel and the underside between binding posts.

f. REASSEMBLY. (1) Clean all contacts with varnish remover, and burnish the contacts.

(2) Reassemble and test for proper operation.

g. MARKING. Mark the letters MFP and the date of treatment near the nameplate on the front of the equipment.

EXAMPLE: MFP—8 June 1944.

30. Step-by-step Instructions for Treating Line Connector Unit EE–87

a. PREPARATION. Make all repairs and adjustments necessary for proper operation of the equipment.

b. DISASSEMBLY. (1) Operate latch and raise cover.

(2) Remove six screws from phenolic panel.

(3) Lift out panel and expose underside.

(4) Remove four screws from relay brackets and raise to expose relay coil.

(5) Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment to be processed.

c. MASKING. (1) Mask contacts of keys.

(2) Mask relay contacts.

(3) Mask relay armature.

d. DRYING. Place equipment in oven or under heat lamps and dry for 2 to 3 hours at 160°F.

e. VARNISHING. Apply three coats of moistureproofing and fungiproofing varnish (Lacquer, Fungus-resistant, Spec. No.

71–2202 (stock No. 6G1005.3), or equal) to the parts of the equipment not covered.

f. REASSEMBLY. (1) Remove all masking tape.

(2) Clean all contacts with varnish remover, and burnish the contacts.

(3) Reassemble and test for proper operation.

g. MARKING. Mark the letters MFP and the date of treatment near the nameplate on the front of the equipment.

EXAMPLE: MFP—8 June 1944.

31. Step-by-step Instructions for Treating Time Interval Signal BE–65

a. PREPARATION. Make all repairs and adjustments necessary for proper operation of the equipment.

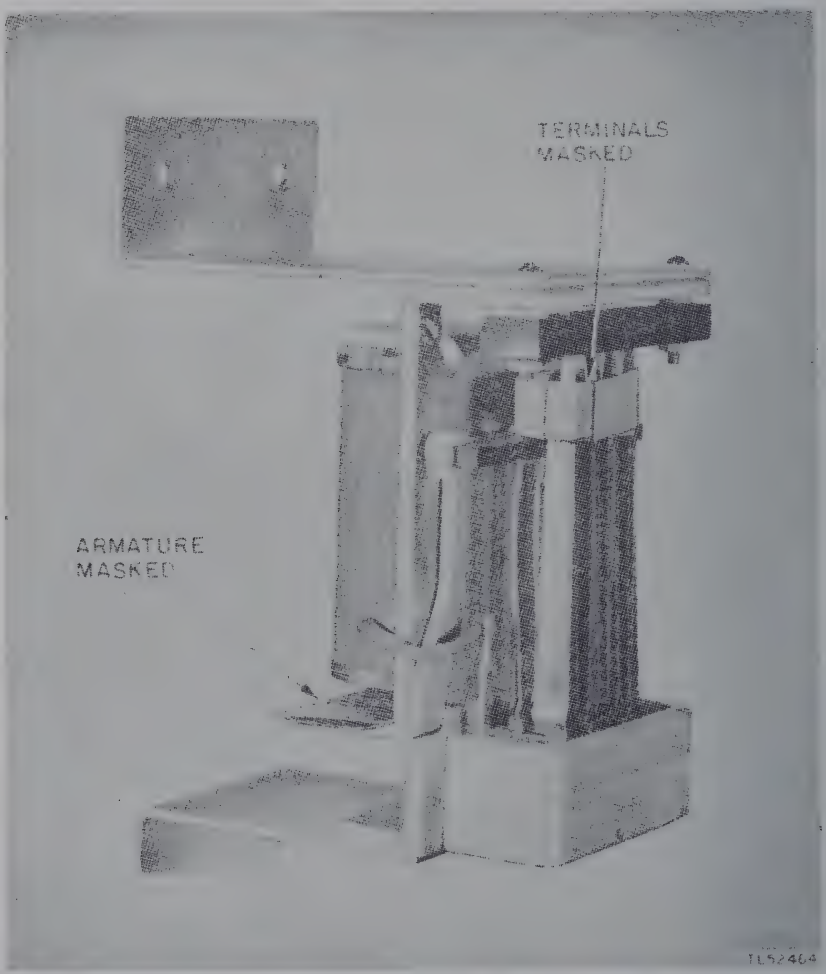

Figure 24. Line Connector Unit EE–87—relay masked.

b. DISASSEMBLY. (1) Remove four screws, holding screen, and take off screen.

(2) Remove four screws underneath screen which holds horn in place.

(3) Stand unit on screen end.

(4) Loosen two knurled screws on cover and open.

(5) Remove two hex nuts and screws holding relay base to bracket.

(6) Remove one screw from each side of case.

(7) Slide horn unit to the rear to clear brackets and lift out of case.

(8) Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment to be processed.

c. MASKING. Masking of this equipment is not required.

d. DRYING. Place equipment in oven or under heat lamps and dry for 2 to 3 hours at 160°F.

e. VARNISHING. Apply three coats of moistureproofing and fungiproofing varnish (Lacquer, Fungus-resistant, Spec. No. 71–2202 (stock No. 6G1005.3) or equal) to the following parts:

(1) Spray varnish on inside of case.

(2) Use brush only in varnishing horn unit.

(3) Varnish relay coil and phenolic base on all edges and sides.

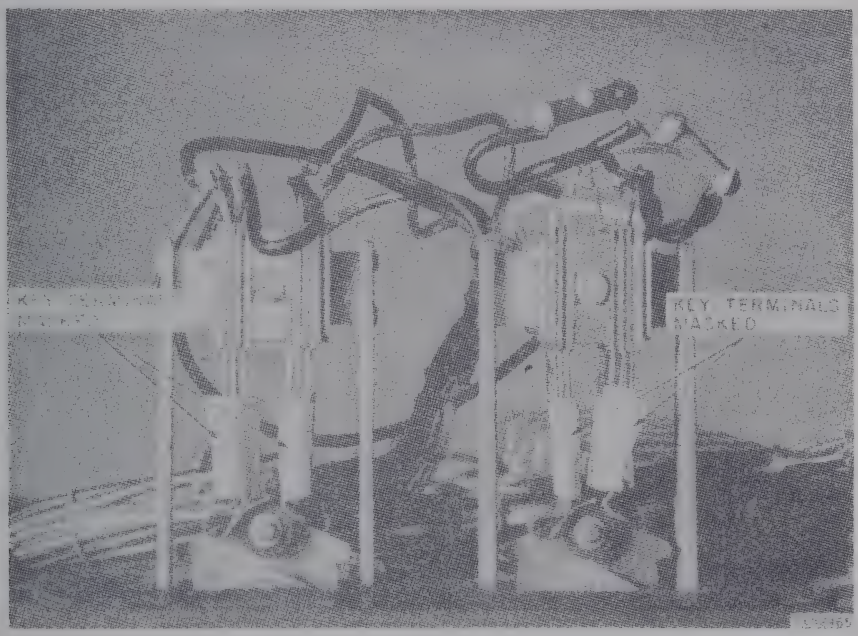

Figure 25. Line Connector Unit EE–87—keys masked.

(4) Varnish the vibrator coil, using great care not to get varnish on the vibrating unit push rod and diaphragm.

(5) Varnish the phenolic binding post base on all edges and sides.

(6) Varnish all wires and soldered connections.

f. REASSEMBLY.

(1) Check all contacts for traces of varnish, and if necessary, clean with varnish remover and burnish.

(2) Reassemble and test for proper operation.

g. MARKING. Mark the letters MFP and the date of treatment near the nameplate on the cover of the equipment.

EXAMPLE: MFP—8 June 1944.

PART FOUR

AUXILIARY EQUIPMENT

(NOT USED)

PART FIVE

REPAIR INSTRUCTIONS

Note: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on WD, AGO Form 468 (Unsatisfactory Equipment Report). For particulars see paragraph 51. If Form 468 is not available, see TM 38–250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form 54 (Unsatisfactory Report). If either form is not available, prepare the data according to the sample form reproduced in figure 42.

Section VIII. THEORY OF OPERATION OF TIME CONTROL EQUIPMENT RC–133

32. Time Interval Apparatus EE–85

a. CLOCK. An explanation of the theory of operation of the clock unit can be divided into three sections: the motor, regulator, and the auxiliary sections.

(1) The motor part of the clock is that part which provides the motion or power for the regulator and auxiliary parts. It consists of a permanent bar magnet suspended on an axle through its center, a two-section coil of wire through which the bar magnet can move, and a contacting mechanism arranged so that the circuit through the coil will be broken when the bar magnet swings a certain distance through the coil. Initially, the bar magnet is at rest outside the coil. When a battery is connected to the terminals of the coil circuit and the contact mechanism, the magnet is caused to swing inside the coil by the magnetic attraction between the bar magnet and the electromagnetic field set up by the current through the coil. When the bar swings through a certain angle into the coil, the contact breaks and the electromagnetic attractive field is no longer present. The counterforce of a spiral spring causes the bar magnet to return to its original position.

(2) The regulator assembly consists of a heavy cylindrical weight suspended on an axle through its center and a heavy spiral spring which is secured to the axle. This combination of weight and spring form a mechanical oscillatory circuit which will oscillate at a rate of exactly 1 cycle per second.

(3) The auxiliary part of the clock consists of a pair of heavy silver contacts and a contact lever arm which holds one of the contacts. The dead end of the spiral spring is attached to this lever arm. When the weight swings clockwise, the lever arm is pulled so that the contacts are broken. When the weight swings in the counterclockwise direction, the lever arm is pulled so that

the contacts close. These auxiliary contacts are closed for 0.4 second during the 1-second period. They control the interval-producing circuit.

b. DRIVING MECHANISM (fig. 26). The driving mechanism includes a driving magnet (24) and armature (23), a drive bar (17) with a drive-bar block (4), a 90-tooth ratchet wheel (1), and a ratchet pawl (7). The instant that the auxiliary contacts close,

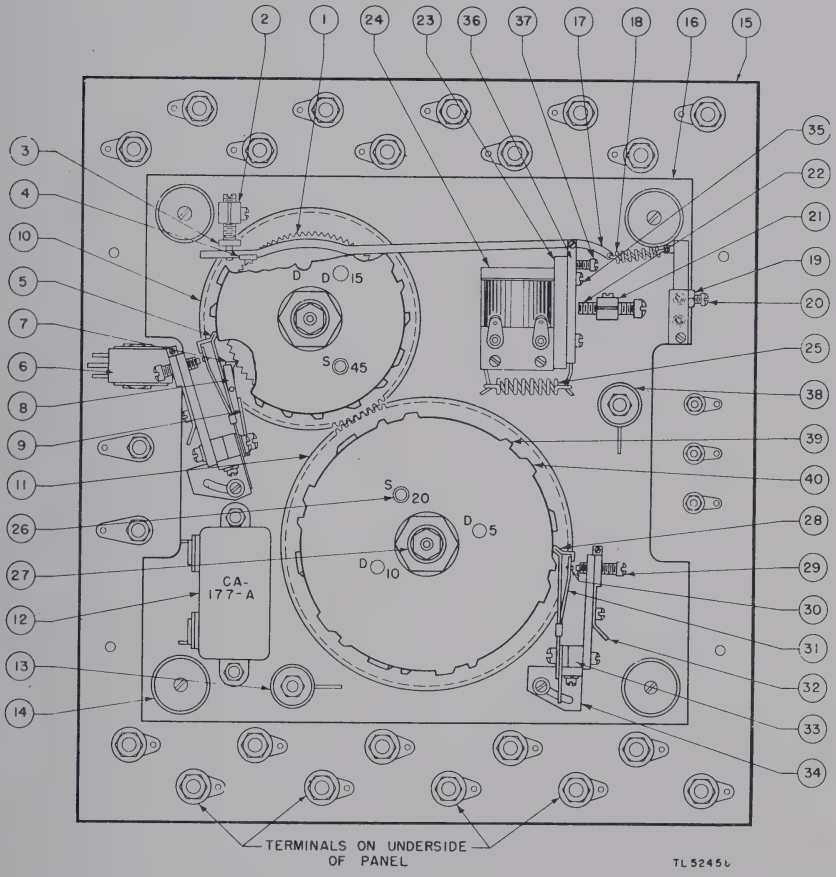

Figure 26. Interval mechanism of Time Interval Apparatus EE–85.

the circuit through the driving magnet is closed and the armature is actuated. The armature in turn causes the drive bar to move past the ratchet wheel. The ratchet hook on the drive bar engages with the teeth of the ratchet wheel and advances the ratchet wheel one tooth. At the completion of the motion, the ratchet pawl engages with a tooth on the ratchet and prevents it from turning backward. Since there are 90 teeth on the wheel and

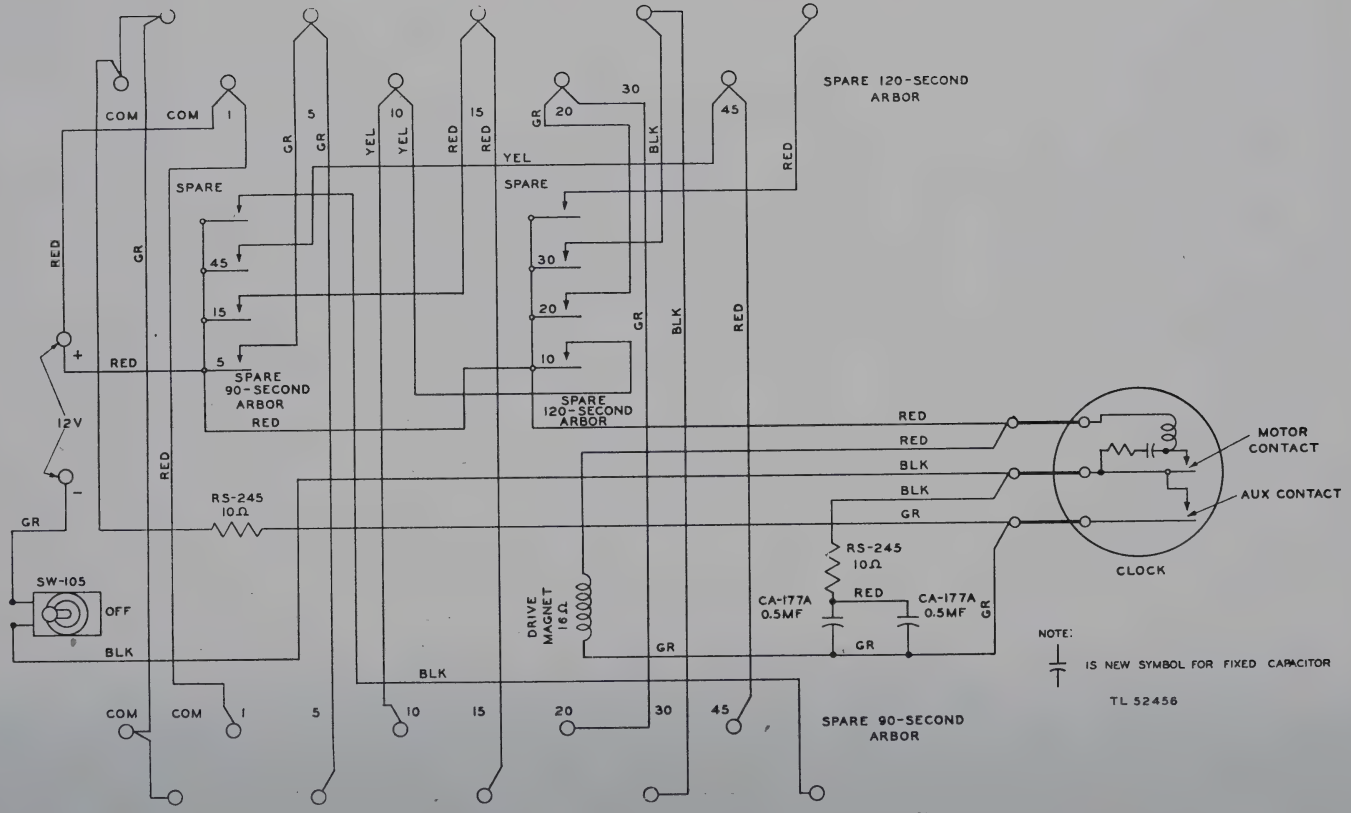

Figure 27. Time Interval Apparatus EE–85—circuit diagram.

advancement is at the rate of 1 tooth per second, the 90-second arbor makes one complete revolution in 90 seconds.

c. INTERVAL-PRODUCING MECHANISM. The interval-producing mechanism includes the arbors, the timing disks, and the contact assemblies. Two arbors are included in the mechanism; one which rotates once in 90 seconds and another which rotates in 120 seconds. Accordingly, these arbors are referred to as the 90-second arbor and the 120-second arbor respectively. The 90-second arbor carries the ratchet and four timing disks as follows: 5-second, 15-second, 45-second, and one spare. The 120-second arbor carries four timing disks as follows: 10-second, 20-second, 30-second and one spare. The two arbors are geared together through spur gears. As the arbors and their respective disks rotate, the shoes of the contact springs come in contact with the timing lobes of the timing disks. When the shoes travel up on the crown of the lobes, the contacts are actuated, thereby completing the circuit through the various interval signal devices.

d. OTHER CIRCUIT COMPONENTS (fig. 27). A circuit limiting resistor is placed in series with the auxiliary contacts of the clock to prevent damage to the apparatus should the auxiliary contacts weld together. An interference filter is connected across the auxiliary contacts to prevent interference with radio and other communication systems.

33. Line Connector Unit EE–87 (figs. 28 and 29)

a. HUMMERS. The hummers each consist of carbon granule elements and an electromagnetic receiver unit. These two units are connected in push-pull in such a manner that an electromechanical resonance is set up between them. This is much the same as the resonance or oscillation that builds up when the receiver unit of a telephone is held near the transmitter. In the case of the hummers, the resonance occurs at 1,000 cycles. The tone produced is carried to the external circuit by a secondary winding on the receiver.

b. RELAY. The purpose of the relay is to close the circuit from the battery through a current limiting resistor, a selector key, and one of the hummers, and to close the circuit through the line coupling transformers, the coupling capacitors, and the external line.

c. VOLUME KEY. The volume key is used to control the volume of the tone to the various telephone lines. In the LOW position, 70,000 ohms are placed in series with the coupling apparatus, in the MED position, 20,000 ohms, and in the LOUD position, 0 ohms.

d. HUMMER KEY. The hummer key is used to start the line connector unit and to select one of the two hummers for operation. At the neutral position the unit is inoperative, and at the two extreme positions one of the two hummers is thrown into operation.

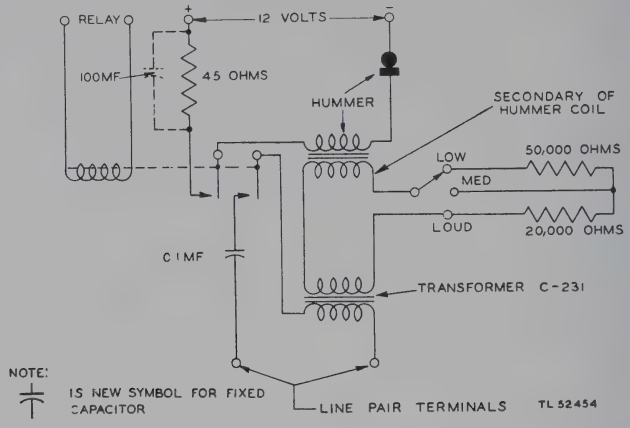

Figure 23. Line Connector Unit EE–87—basic circuit.

e. COUPLING CIRCUITS. The coupling circuits consist of six Transformers C–231, six Capacitors CA–166, and six pairs of contacts on the relay. The primaries of the transformers are connected in series. The secondary winding of the hummer is connected to the ends of the series chain of primaries through the volume key. One terminal of each secondary is connected directly to one terminal of each line pair. The other terminal of the secondary is connected to one of each of the relay contact pairs. The other of the contact pair is connected to the second terminal of the line pairs through the 0.1-microfarad capacitors. This coupling arrangement, since it blocks direct current, prevents false supervision on the lines to which the unit is connected. The use of separate transformers minimizes crosstalk which might arise from the insertion of the line connector unit into the circuit.

34. Time Interval Signal BE–65 (fig. 30)

a. RELAY. The relay is used to operate the horn from the relatively weak signal from the time interval apparatus. The high-resistance relay winding is connected to the line from the time interval apparatus. When a signal is transmitted, the relay armature is actuated.

b. HORN. The actuation of the relay closes the circuit through the coil of the horn. The horn coil produces an electromagnetic

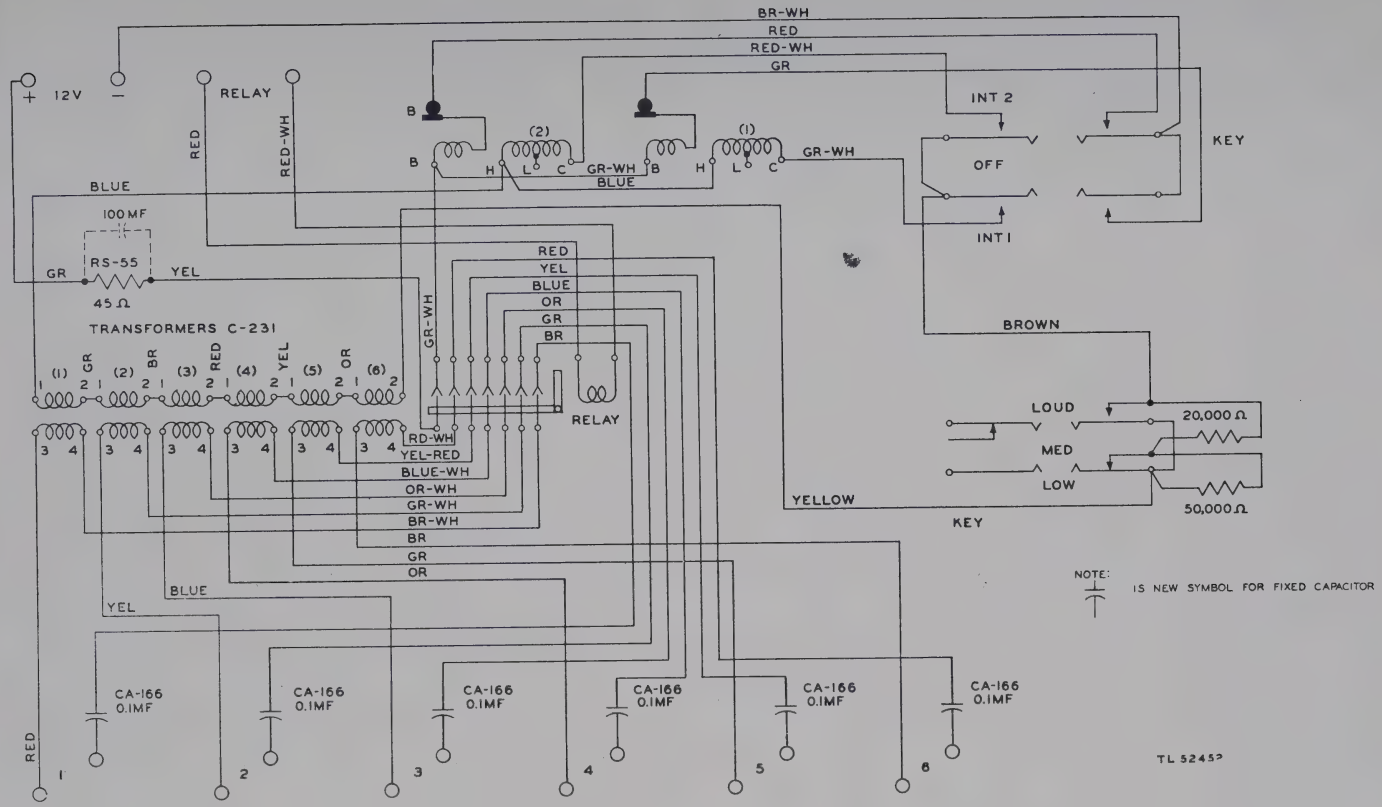

Figure 29. Line Connector Unit EE–87—circuit diagram.

force which pulls the post armature toward the pole piece. As the post moves with the armature, it breaks a contact which opens the horn coils circuit. The resilience of the diaphragm returns the post to the original position, closing the contact, and the cycle is repeated. The pitch of the horn depends upon the rapidity with which the contacts are closed and opened.

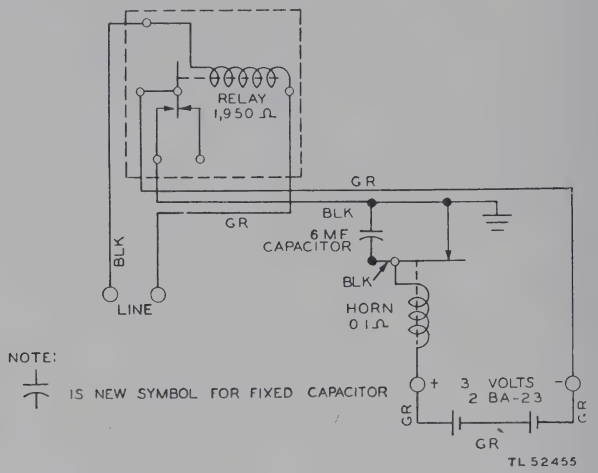

Figure 30. Time Interval Signal BE–65—circuit diagram.

Section IX. TEST EQUIPMENT

35. Test Set I–56–( )

a. COMPONENTS. (1) Combination tester including tube checker, capacitance tester, voltmeter, ammeter, ohmmeter, and free-point tester.

(2) Output meter.

(3) Voltohmmeter.

b. USE WITH TIME CONTROL EQUIPMENT RC–133. Test Set I–56–( ) is used in higher echelon maintenance for checking capacitors, resistance, voltage, and current at various points in the circuit and hummer output.

c. REFERENCES. For instructions on the use of Test Set I–56–( ), consult the instructions contained with the equipment.

36. Test Set TS–26/TSM

a. GENERAL. Test Set TS–26/TSM is a voltohmmeter for line testing. It is used to detect grounds, crosses, shorts, and opens, and to measure insulation and conductor resistance as well as line and battery voltage. It also may be used for the locations of opens by means of the capacitance kick method. The test set con-

sists of a single major unit and is supplied in the field complete with all batteries and test leads required for use of the equipment.

b. USE WITH TIME CONTROL EQUIPMENT RC–133. This test set is used with the time control equipment for making line tests and measuring voltage, current and resistance in the various circuits.

c. REFERENCES. For further information regarding the operation and use of Test Set TS–26/TSM, see TM 11–2017.

37. Test Set EE–65–( )

a. GENERAL. Test Set EE–65–( ) has previously been issued in place of Test Set TS–26/TSM. Test Set EE–65–( ) is a compact, portable wire chief's test set for use both in the field and in permanent central office installations. The complete equipment is installed in a substantial case to which is attached a shoulder strap, and can be transported by one man. It is arranged for testing, signaling, and talking

b. USE WITH TIME CONTROL EQUIPMENT RC–133. Test Set EE–65–( ) is used with Time Control Equipment RC–133 for line measurements and voltage and resistance measurements.

c. REFERENCES. For instructions on the use of Test Set EE–65–( ) see the instructions contained with the equipment. See also TM 11–361, Test Sets EE–65 and EE–65–A through –G.

Section X. TROUBLE SHOOTING

38. General Trouble-Shooting Information

No matter how well equipment is designed and manufactured, faults occur in service. When such faults occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble shooting.

a. TROUBLE-SHOOTING DATA. Take advantage of the material supplied in this manual to help in the rapid location of faults. Consult the following trouble-shooting data when necessary:

(1) Block diagram of Time Control Equipment RC–133.

(2) Complete schematic diagram of each component.

(3) Simplified and partial schematic diagrams. These diagrams are particularly useful in trouble shooting, because the repairman can follow the electrical functioning of the circuits more easily than on the regular schematics, thus speeding trouble locating.

(4) Voltage and resistance data between connecting points in the circuit.

(5) Illustration of components. Front, top, and bottom views which aid in locating and identifying parts.

b. TROUBLE-SHOOTING STEPS. The first step in servicing a defective time control equipment is to sectionalize the fault. Sectionalization means tracing the fault to the component or circuit responsible for the abnormal operation of the equipment. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors, arcing, and shorted coils can be located by sight, smell, and hearing. The majority of faults, however, must be located by checking voltage and resistance.

c. SECTIONALIZATION. Careful observation of the performance of the time control equipment while turning it on often sectionalizes the fault to the time interval apparatus, the line connector unit, or the time interval signal. Additional sectionalization of faults will be discussed in paragraph 40.

d. LOCALIZATION. Paragraphs 41 to 43 describe the method of localizing faults within the individual components. These paragraphs are accompanied by trouble-shooting charts which list abnormal symptoms and their probable causes. The charts also give the procedure for determining which of the probable locations of the fault is the exact one. In addition, there are a number of charts which show the resistance and voltage at important points in the circuit.

e. VOLTAGE MEASUREMENTS. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from abnormal voltages or produce abnormal voltage. Voltage measurements are taken easily, because they are always made between two points in a circuit and the circuit need not be interrupted.

39. Trouble-Shooting Procedures

The accompanying trouble-shooting charts, if properly used, simplify trouble shooting. The charts are arranged in four groups. The first group covers sectionalization of the fault in the system as a whole. The second group covers localization of the fault in Time Interval Apparatus EE–85. The third group covers localization of the trouble in Line Connector Unit EE–87. The fourth group of charts localizes trouble in Time Interval Signal BE–65. Therefore, the first group of charts will be used mainly by the operator, whereas the last three, covering trouble shooting within the components, will be used by the repairmen.

40. Trouble Chart for Sectionalizing Trouble in Time Control Equipment RC–133.

Symptoms	Probable trouble	Corrections
One Time Interval Signal BE–65 inoperative.	Loose battery connections.	Tighten all battery connections.
	Loose field wire connections.	Tighten all field wire connections.
	Batteries BA–23 worn out.	Replace Batteries BA–23.
	Broken field wire.	Repair or replace field wire.
	Line from time interval apparatus too long.	Shorten line, if possible, or centralize time interval apparatus.
	Relay winding open.	Replace signal.
	Horn contacts out of adjustment.	Adjust contacts.
All Time Interval Signals BE–65 inoperative.	Time Interval Apparatus EE–85 inoperative.	Listen for click of driving magnet. Proceed according to paragraph 41.
	Battery connections to time interval apparatus not tight.	Tighten battery connections.
	COM connection to time interval apparatus broken or loose.	Repair or tighten connection.
	Connection to interval terminal on time interval apparatus broken or loose.	Check connections to all terminals.
Timing of interval too fast.	Battery connections on time interval apparatus reversed.	Reverse battery connections to time interval apparatus.
Signal once every second.	Time interval apparatus faulty.	Proceed according to paragraph 41.
No tone signal on telephone lines.	Line Connector Unit EE–87 inoperative.	Proceed according to paragraph 42.
	Connections to line connector unit loose.	Tighten all connections.
	Connections to telephone line strip loose.	Tighten connections at strip and line connector unit.
	Battery connections to line connector unit loose.	Tighten battery connections.

41. Trouble Chart for Localizing Trouble in Time Interval Apparatus EE–85

Symptoms	Probable trouble	Corrections
Time Interval apparatus EE–85 does not start.	Clock contacts in open position.	Rotate time interval apparatus.
	Clock winding open.	Replace clock.
	Auxiliary contacts not making.	Check and repair contacts (par. 44*a*(1)).
	Driving magnet open.	Replace driving magnet.
	Capacitor CA–177–A shorted.	Check and replace faulty capacitor.
Time interval apparatus produces 1-second signals only.	Drive magnet open with interval contacts in operated position.	Replace drive magnet (par. 44*b* (1)).
	Drive-bar tension spring too loose.	Tighten spring.
	Contact shoe pressure too heavy.	Adjust spring pressure.
	Interval contacts welded together.	Separate and dress contacts.
Time interval apparatus does not signal on one program but does on all others.	Contact for program disk out of adjustment.	Adjust contact.
	Connection between contact and terminal broken.	Repair connection.
Time interval apparatus operates irregularly.	Auxiliary contacts of clock burned or worn.	Repair contacts or replace clock (par. 44*a*).
	Drive-bar tension spring out of adjustment.	Adjust tension of spring.
	Drive block worn.	Replace drive block.
	Filter across auxiliary contacts open.	Replace faulty component.
	Timing contacts out of adjustment.	Increase pressure of contacts.
Time interval apparatus produces noise in radio equipment.	Filter on motor contacts of clock open.	Replace clock.
	Filter on auxiliary contacts of clock open.	Replace faulty component.
Interval mechanism jumps more than one position at each operation.	Armature set for too great a swing.	Set armature adjustment screw for smaller swing.
	Drive-bar stop out of adjustment.	Set stop until drive block engages only one notch at a time.

42. Trouble Chart for Localizing Trouble in Line Connector Unit EE–87

Symptoms	Probable trouble	Corrections
No tone on any telephone lines; relay heard operating.	Battery connections loose.	Tighten battery connections.
	Hummer dirty or blocked.	Clean hummer, especially reed.
	Hummer key contacts dirty or out of adjustment.	Clean and adjust hummer key.
	Secondary of hummer shorted or open.	Replace hummer.
	Relay contact dirty.	Clean relay contacts (par. 20*b*).
	Transformer C–231 primary open.	Replace faulty transformer.
No tone on some telephone lines; relay heard operating.	Connections to terminal strips loose.	Check all connections to terminal strip.
	Secondary winding of line transformer open or shorted.	Replace faulty transformer.
	Relay contacts dirty or out of adjustment.	Clean and adjust relay contacts (par. 20*b*).
No tone on any lines; relay not heard operating.	Relay winding open.	Replace relay.
	Connections to relay winding broken.	Check connections and repair.
	Connection to RELAY terminals loose.	Check connections and repair.
Tone irregular.	Hummer out of adjustment.	Adjust hummer for regular tone.
	Locknut on hummer adjustment loose.	Tighten locknut.
	Series resistor intermittent.	Replace resistor.
	Carbon button defective.	Replace hummer.
	Carbon granules frozen.	Tap carbon button.
Cross talk on telephone lines.	Line contacts on relay sticking closed.	Clean and adjust relay contacts (par. 20*b*).
	Line contacts shorted across.	Check wiring and connections.
Tone volume low on LOUD position.	Hummer out of adjustment.	Adjust hummer.
	Hummer defective.	Replace hummer.

43. Trouble Chart for Localizing Trouble in Time Interval Signal BE–65

Symptoms	Probable trouble	Corrections
No signal; relay operates.	Capacitor shorted.	Replace capacitor.
	Contacts out of adjustment.	Adjust horn contacts (par. 21*e*).
	Batteries BA–23 worn out.	Replace batteries.
	Loose battery connections.	Tighten battery connections.
	Contacts worn out.	Replace horn contacts.
	Relay contacts dirty or out of adjustment.	Adjust and clean relay contacts (par. 21*e*).
No signal; relay does not operate.	Relay winding open.	Replace relay.
	Terminal connections loose.	Tighten connections.
	Field wire broken.	Check and repair field wire.
	Connections from terminal to relay winding broken.	Check and repair connections.
Signal tone rasps.	Contacts out of adjustment.	Adjust contacts (par. 21*e*).
	Post out of adjustment.	Adjust post and tighten locknut (par. 21*e*).
	Armature gap uneven.	Adjust armature gap (par. 21*e*).
Signal only gives plunk.	Capacitor shorted.	Replace capacitor.
	Contacts out of adjustment.	Adjust contacts (par. 21*e*).

Section XI. REPAIRS

44. Time Interval Apparatus EE–85

a. CLOCK. (1) *Contacts.* (*a*) *Motor contacts.* To dress the motor contacts, follow the procedure below:

1. Remove the transparent cover from the mechanism by loosening the four brass screws on the locking plate.

2. Grasp the unit by the top plate, hold it upside down, and hold the magnet with the thumb to prevent the mechanism from oscillating (fig. 31).

3. Insert a small contact burnishing tool between the two contact springs and move it back and forth gently between the contacts. Take care not to alter the tension or permanent position of either spring during this operation.

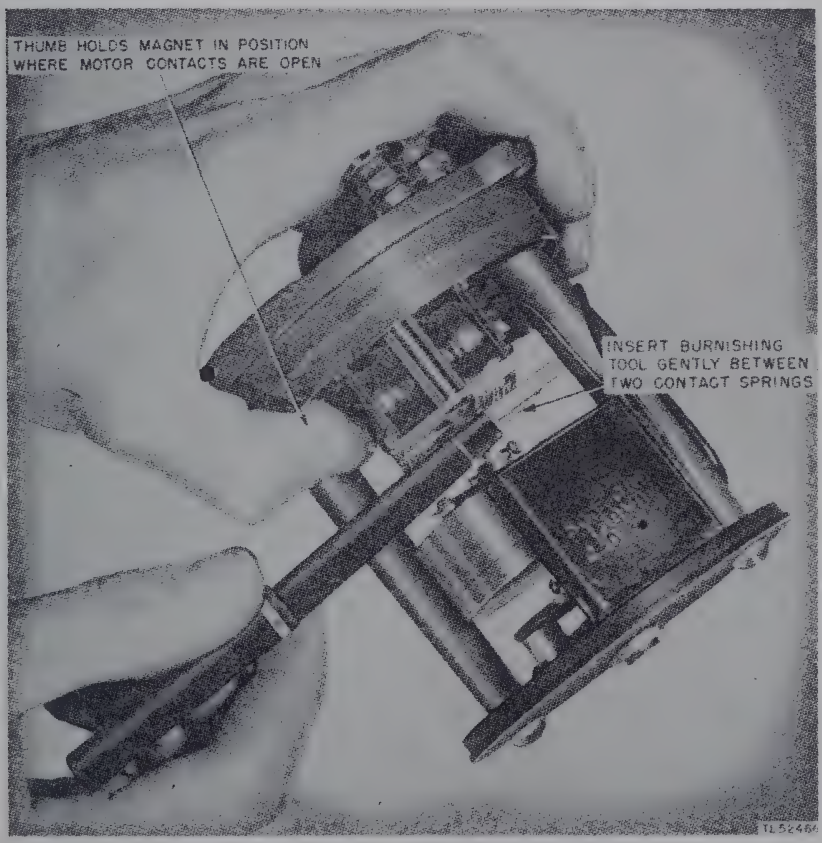
THUMB HOLDS MAGNET IN POSITION WHERE MOTOR CONTACTS ARE OPEN
INSERT BURNISHING TOOL GENTLY BETWEEN TWO CONTACT SPRINGS

Figure 31. Cleaning clock motor contacts.

4. Rotate the mechanism so the contracts are in the open position, and adjust the contacts to a clearance of 0.004 inch.

(*b*) *Auxiliary contacts.* Dress the auxiliary contacts in the following manner:

1. Grasp the unit by the top plate, hold it upside down, and hold the cylindrical weight with the finger in such a position that the auxiliary contacts will remain open (fig. 32).

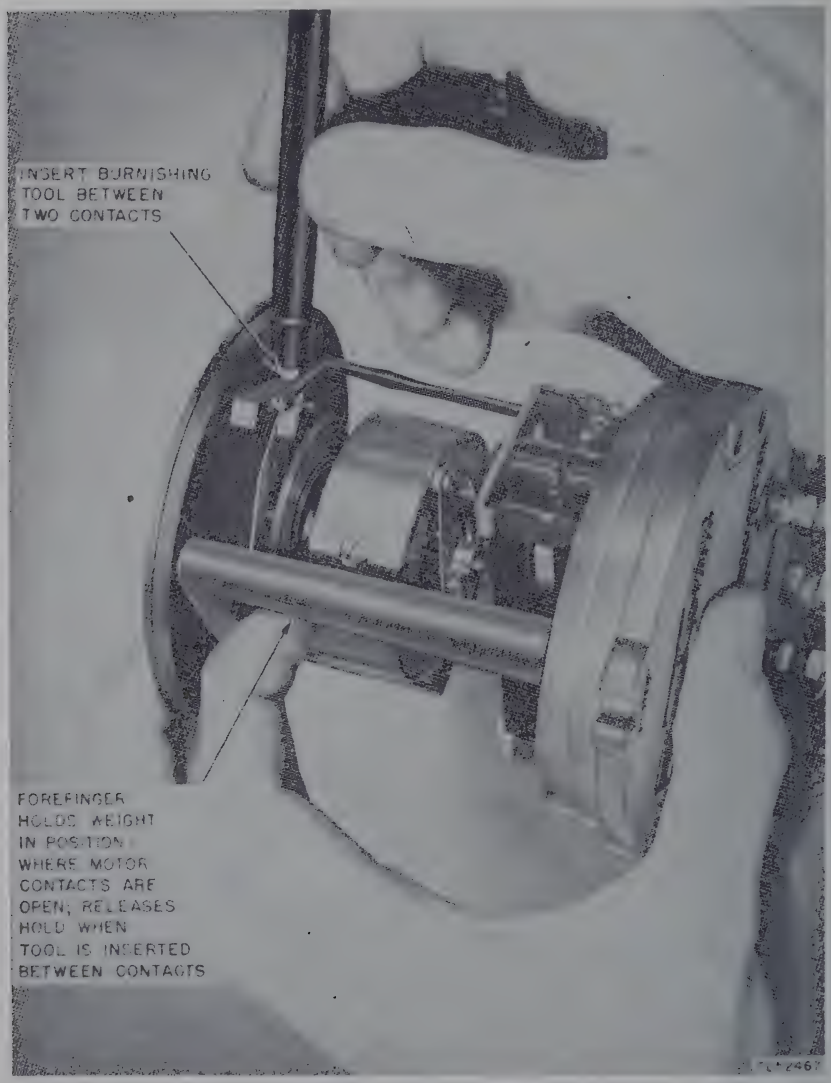
INSERT BURNISHING TOOL BETWEEN TWO CONTACTS
FOREFINGER HOLDS WEIGHT IN POSITION WHERE MOTOR CONTACTS ARE OPEN; RELEASES HOLD WHEN TOOL IS INSERTED BETWEEN CONTACTS

Figure 32. Cleaning clock auxiliary contacts.

2. Clean each contact with a burnishing tool. Make sure that the two contact surfaces match perfectly when the contacts make.

(2) *Pivot Adjustment.* The end play of the shaft is adjusted by adjusting the lower pivot screw. To adjust this screw, loosen the locknut on the bottom plate and turn the screw in or out as required. Set the screw for a slight longitudinal play in the axle. When the pivot is correctly adjusted, there should be no lateral shaft play.

b. Driving Mechanism.

(1) *Driving magnet.* To remove and replace the driving magnet, follow the procedure given below:

(*a*) Disengage the drive bar from the armature arm by removing the small pivot screw.

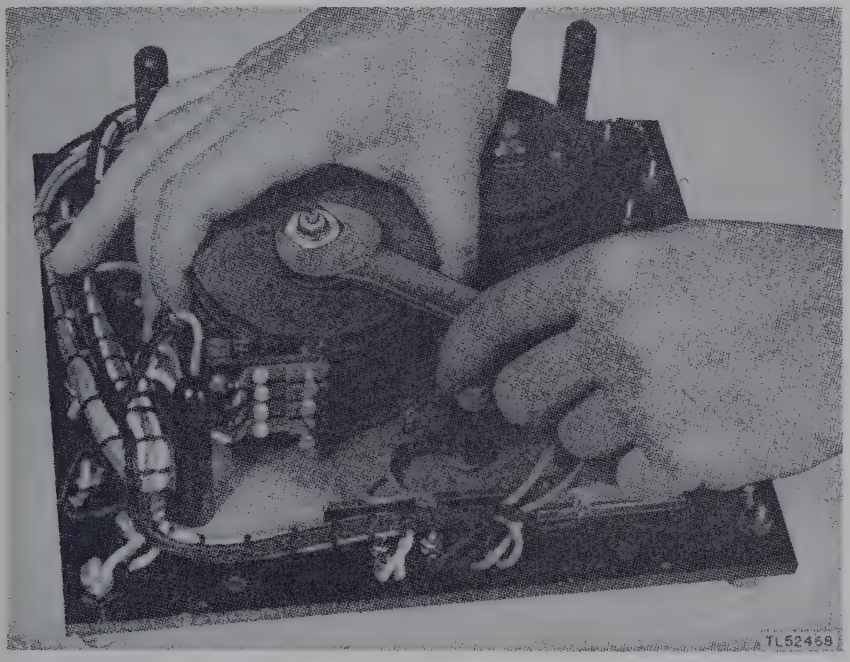

Figure 33. Removing timing disks.

(*b*) Twist the four supporting posts in a counterclockwise direction to remove them.

(*c*) Lift the brass floor plate of the unit away from the panel.

(*d*) Grasp the driving magnet with one hand and hold the armature and armature arm in contact with the pole pieces of the magnet.

(*e*) Remove the three fillister-head brass screws from the bottom of the brass plate. The driving magnet will come off.

(*f*) To replace the driving magnet, reverse the procedure outlined above.

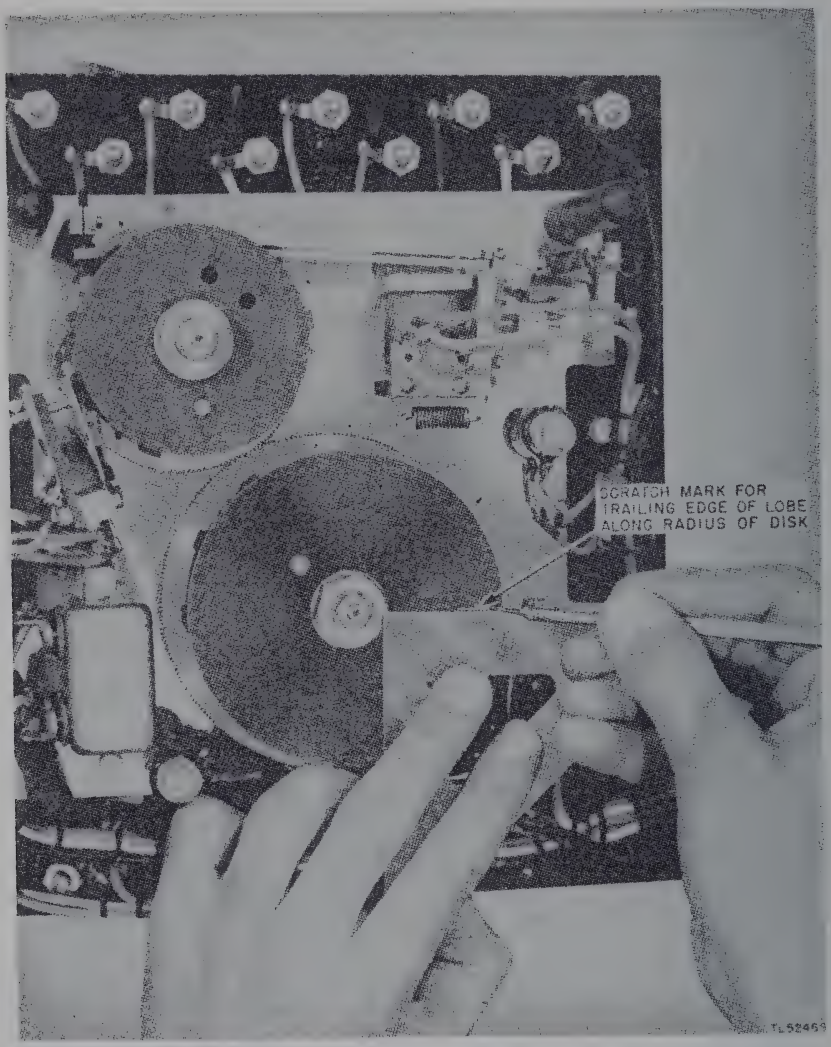

Figure 34. Marking trailing edge of lobe on new timing disk.

(2) *Drive bar.* (*a*) The drive bar is removed in the following manner:

1. Unhook the drive-bar tension spring.
2. Remove the small pivot screw which holds the armature to the drive bar.

3. Lift the drive bar away from the mechanism.

(*b*) The fitting which engages the ratchet wheel may be removed by unscrewing the two small screws which hold it in place.

c. INTERVAL MECHANISM. (1) *Contact assemblies.* (*a*) *Springs.* To remove the springs for adjustment or cleaning, remove the fillister-head brass screw which secures each spring to the contact mounting post. When reassembling the springs, bend each spring so that the contact spring will clear the overhanging portion of the shoe by 0.04 inch when the shoe is on top of a timing lobe. The movable contacts can be replaced only by replacing the entire spring assembly.

(*b*) *Fixed contacts.* Before removing the fixed contact screws for replacement or cleaning, make sure that the small locking screws are loosened.

(2) *Disks.* The disks may be removed by unscrewing the large nut at the top of each arbor post (fig. 33). When removing or replacing disks, hold the disk assembly with the hand while tightening or loosening the large nut on the arbor post. If a disk has been damaged or broken or a new time interval program is desired, a new disk must be cut. To cut a new disk, proceed as follows:

(*a*) Remove the top disk from the proper arbor post and replace it with a blank disk of the proper size.

(*b*) Determine the synchronizing position of the mechanism by holding the driving magnet armature in the operated position and rotating the arbors by hand until the mating marks on the two gears coincide. Then operate the armature manually a few times until the spring shoes are about to fall off the timing lobes. This is the synchronizing position. If the new disk is to be synchronized with the other, the trailing edge of a timing lobe will be cut at this point. Scratch the surface of the disk to mark this point (fig. 34).

(*c*) If the interval of the new disk is to be delayed with respect to the others, operate the armature manually for the required number of seconds delay. A trailing edge of a timing lobe will appear at this point. Scratch the surface to mark the point.

(*d*) A point on the circumference of either size disk moves approximately 3/32 inch for each time the armature operates, that is, 3/32 inch per second. The top surfaces of the lobes should be as short as possible, but not less than 3/64 inch for a 1-second lobe. This permits more clearance between the flanks of the lobe and the nearest surface of the spring shoe. Scratch the outlines of all the lobes which should be on the finished disk, including the angle of each cut to be made. When cutting new disks, remember that the spring shoe must not touch either edge

of the lobe when the disk assembly is resting in the positions immediately before or after those in which the contacts are closed. This might cause the entire apparatus to jam, and is especially true of the trailing edge of the lobe.

(*e*) Starting at the scratch made at the synchronizing position, operate the armature once for each second of interval between firing signals, and make another scratch. Repeat this operation, starting each time at the new scratch, until all of the interval positions have been marked. Make these marks in line with a radius of the disk.

Figure 35. Marking leading edge of lobe on new timing disk.

(*f*) Operate the armature of the driving magnet once for each second between the firing signal and the warning signal for the next firing signal. This point will be the leading edge of the lobe. Scratch a sloping mark (the same angle as used on standard disks) from this point (fig. 35). Repeat this operation for all

firing positions. If warning lobes are required, they also should be marked with the start and finish positions.

(*g*) Trailing edges of lobes must coincide with a radius of the disk; leading edges of lobes must be sloped to help the movement of the contact finger, the same as on other disks.

Caution: Be sure that all the required lobes are completely outlined on the disk before starting to cut them, to avoid cutting off a lobe position.

(*h*) Remove the disk from the arbor; cut out the unwanted material with a hacksaw and chisel. Smooth all surfaces with a file. The low parts of the disk need not be particularly smooth or even parts of a true circle. Near the driving hole of the disk and on the side of the disk which is visible when it is on the arbor, stamp or engrave the letter *S* if the lobes are in synchronism with the lobes of the other disk. If the disk is to give a delayed program, stamp or engrave the letter "D" followed by the number of seconds delay.

(*i*) The following intervals, for which disks are not already provided, can be obtained by special cutting. On the 90-second arbor, intervals of 2, 3, 6, 9, 18, or 90 seconds can be obtained. On the 120-second arbor, intervals of 2, 3, 4, 6, 8, 12, 24, 40, 60, or 120 seconds can be obtained. Use the smaller arbor for any intervals which it can generate, to reduce the number of lobes which must be cut on the disk.

(*j*) All interval signals must be a whole number of seconds apart. For instance, it is impossible to get interval signals 4½ seconds apart by cutting 20 lobes on a disk to be used on the 90-second arbor. Fractional intervals cannot be obtained because the clock which supplies power to all contacts operates the timing contacts only once a second for a period of 0.4 second. All motion of the disk assemblies occurs in the remaining 0.6 second. It is possible to cut a special disk which would give a series of irregular intervals, so long as the intervals add up to the revolution time of the particular arbor on which the disk is mounted. For example, a disk for the 90-second arbor can be cut to give firing intervals of 11, 8, 13, 22, 10, 6, and 20 seconds, and then repeat. Remember that such a series of intervals is difficult to synchronize with the regular intervals generated by the other disks.

45. Line Connector Unit EE–87

a. Binding Posts TM–195. This binding post is used for the relay and line terminals of the line connector unit. If the terminals bind or are damaged, remove them by removing the nut and washer underneath the panel, and replace them.

b. BINDING POSTS TM–109. This binding post is used for the battery terminals. If the bakelite insulation becomes chipped or if the binding post binds, remove the post and replace it with a new one.

c. CAPACITOR CA–166. If any Capacitor CA–166 becomes shorted or leaky, the capacitor must be replaced. Replace the capacitor as follows:

(1) Unsolder the connecting wires from the terminal lugs of the faulty capacitor.

(2) Loosen and remove the nuts which hold the part in place.

(3) Replace the capacitor by reversing the above steps.

d. HINGE. During hard use, the hinge for the lid of the line connector case may be broken. Remove the pieces of the old spring and all the hinge mounting screws. Replace the hinge with a new one. If the mounting screw holes are stripped, fill them with a matchstick or a small piece of wood.

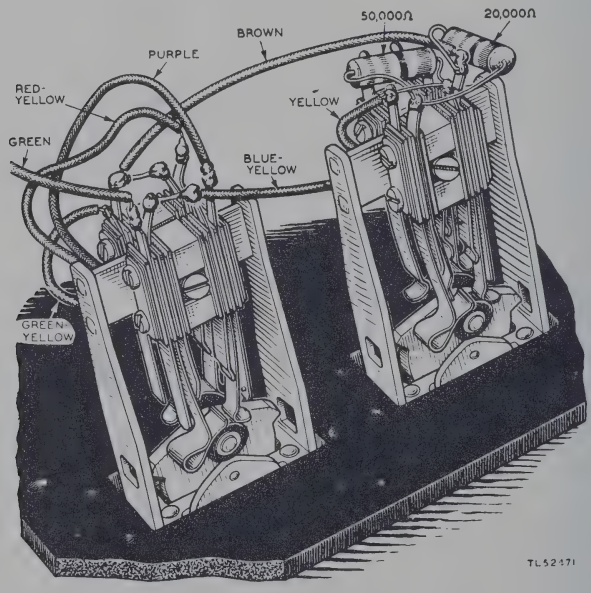

Figure 36. Connection diagram for keys on line connector unit.

e. KEYS. If any of the springs or other parts of the keys are broken, replace the key. Before removing the old key, check the connections against the connection diagram (fig. 36). Unsolder all connections and remove the resistors, remove the screws on the faceplate of the key, and the key will fall out. When replacing the key, secure it to the panel by the screws in the faceplate and then resolder the connections. When replacing the resistors, wrap

the pigtails around the terminal lug twice and resolder. This assures a connection which is not dependent upon the strength of the solder for its strength.

f. HUMMERS. When removing the hummers for preventive maintenance or repairs, both hummers must be removed because of the restricted length of the connecting wires. The hummers are removed from the case by removing the two wood screws

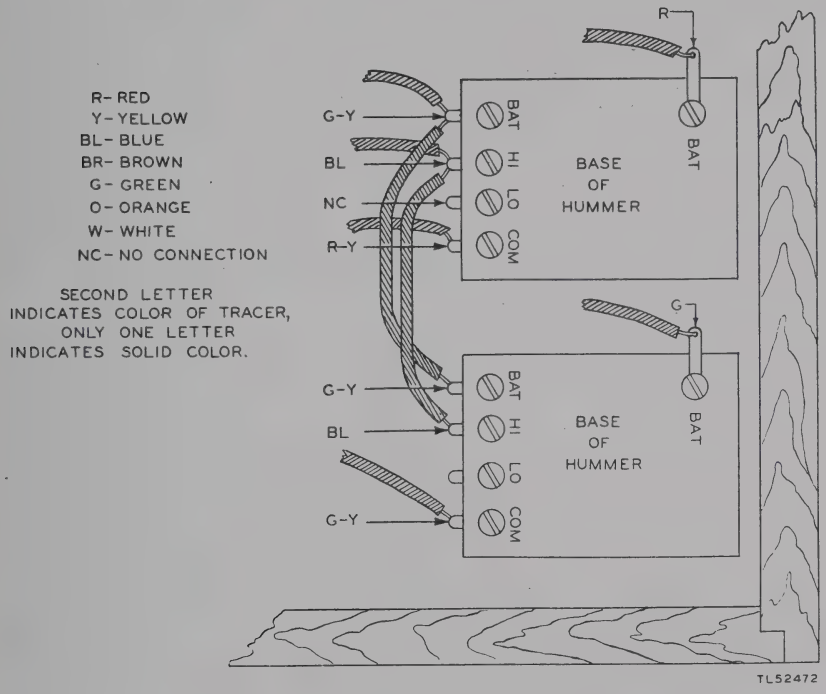

Figure 37. Connection diagram for hummers in line connector unit.

which secure each unit to the wood case. When lifting the units from the case, take care not to strain or break the connecting wires. The cleaning and adjustment of the hummers is covered in part three. If the hummer is to be replaced, check the connections against the connection diagram (fig. 37) before unsoldering any wires.

g. PANEL. If the panel becomes cracked or broken, it must be replaced. To replace the panel, all components mounted thereon must be removed. The only soldered connections that need be removed are those on the two keys. The remainder of the components may be removed in one group by first removing all nuts on the terminals and mounting lugs and then lifting the components and cabled wiring off the panel. Reverse the procedure to

install the new panel. Check all connections made on the new panel against the connection diagram (fig. 38).

h. RELAY. (1) The relay is removed for cleaning, adjustment, repair, or replacement as follows:

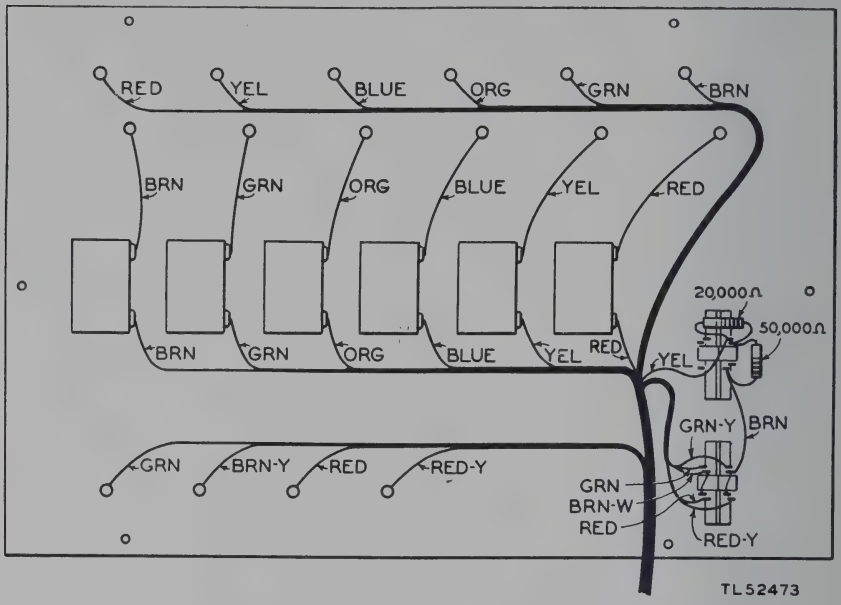

Figure 38. Connection diagram for panel of line connector unit.

(*a*) Remove the four roundhead steel wood screws which hold the relay in place.

(*b*) Lift the relay out of the case. Take care not to strain or break the wires to the relay terminals.

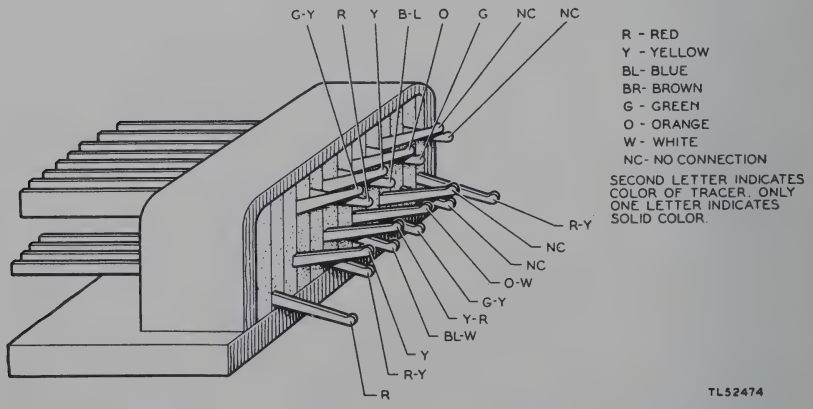

Figure 39. Connection diagram for line connector relay.

(2) To replace the relay, it is necessary to remove all wires from the terminal lugs. Before removing any wires, check the color code with the connection diagram (fig. 39).

(3) Adjustment and cleaning of the relay is covered in part three.

i. RESISTORS. (1) *Resistor RS–55.* Resistor RS–55 is replaced in the following manner: remove the nut at the top of the mounting screw of the resistor. Slip the resistor off over the screw, and unsolder the wires from the terminal lugs. In some models of this equipment, a 100-microfarad capacitor is shunted across this resistor. Take care in removing the capacitor pigtails not to break them off. When replacing the resistor, first solder the capacitor pigtails in models so equipped, and the terminal wires, then slip the resistor over the mounting screw and replace the nut and washers.

(2) *Volume-key Resistors.* To remove and replace the 20,000-ohm and 50,000-ohm resistors used in the volume control circuits, clip the resistors with diagonal cutters and then remove the remaining wire from the key terminal lug. When replacing these resistors, wrap the pigtail two or three times around the terminal lug before soldering.

j. CARRYING STRAP. If the carrying strap is broken or badly worn, remove it by removing the clamping plate on each side of the wooden case of the unit. Make sure that the new strap is stretched tightly before clamping it in place. After the new strap is clamped tightly in place, trim off any excess web material which projects past the end of the clamp.

k. TRANSFORMER C–231. If any Transformer C–231 is found to be electrically or mechanically defective, it must be replaced. To replace the transformer use the following procedure:

(1) Remove all connections from the faulty transformer.

(2) Remove the small mounting screws which fasten the strip to each transformer.

(3) Remove the large screws which hold the transformer clamping strip for the row of transformers in which the faulty transformer is mounted.

(4) Pull off the clamping strip and lift the transformer out of the case.

(5) To replace the transformer, reverse the procedure given above.

46. Time Interval Signal BE–65

a. RELAY. The relay may be removed for cleaning or replacement by removing the four screws which hold it to the case. Before removing these screws, disconnect all wires from the relay

base. Replace the relay if it is electrically or mechanically defective.

b. CAPACITOR. The capacitor can be removed by unscrewing the two capacitor mounting screws on the frame of the horn. The capacitor can be removed only if the relay has been previously removed. The capacitor must be replaced if it is found to be leaking or shorted.

c. POST CONTACTS. The post contacts often become pitted and burned beyond repair. This occurs primarily when the capacitor is leaking or is open circuited. When the contacts are damaged beyond repair, they are removed and replaced as follows:

(1) Remove the two screws which hold the contact spring.

(2) Lift the contact spring assembly off. The fixed contact will be seen between the contact adjusting screw and the post bumper.

Figure 40. Replacing horn in case.

(3) Unscrew the fixed contact with long-nose pliers.

(4) Replace the contact spring and the fixed contact by reversing the procedure above.

d. GENERAL ASSEMBLY. To remove and replace the entire horn assembly, proceed as follows:

(1) Remove the four screws which hold the grill in place.

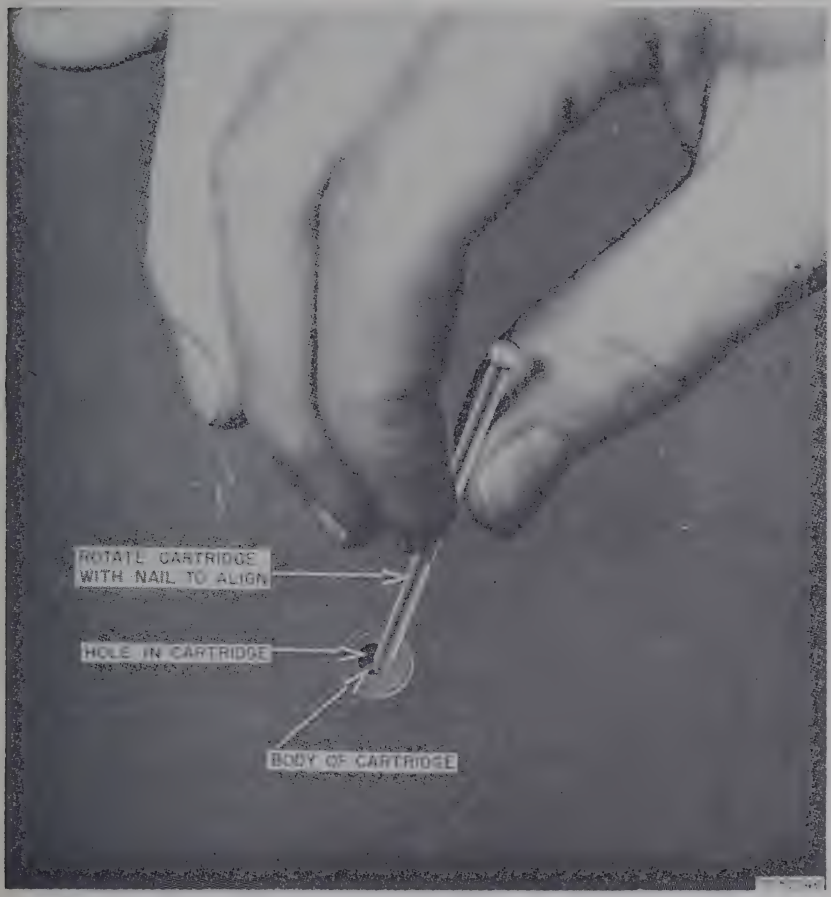

Figure 41. Aligning cartridges in time interval signal.

(2) Remove the four screws on the top of the case which hold the relay in place.

(3) Remove the two large screws on the sides of the case. These are the primary mounting screws for the unit assembly.

(4) Turn the horn so that the back of the case is pointed downward. Grasp the sides of the case and spread them until the unit drops away from the friction holding lugs inside the case.

(5) Remove the two screws on the terminal panel and let the panel swing free.

(6) Place the unit in its normal position and lift the horn assembly out and up.

(7) Replace the unit by reversing the procedure above (fig. 40). When reversing step in (3) above, it may be necessary to insert the point of a knife through the holes in the side of the case and rotate the cartridge. Rotate the cartridges until the threaded hole in each of the cartridges can be seen through the holes in the case (fig. 41). Thread the large mounting screws through the holes in the case into the threaded holes in the cartridges.

47. Rustproofing

a. GENERAL. The only part of Time Control Equipment RC–133 which will require rustproofing will be Time Interval Signal BE–65. Rustproofing will be necessary when the olive-drab finish on the surface of the metal case is damaged so that the bare metal is exposed.

b. TREATMENT. To rustproof the case of Time Interval Signal BE–65, proceed as follows:

(1) Use No. 00 or No. 000 sandpaper to clean the surface down to the bare metal around the area where the finish is damaged. Obtain a smooth bright finish.

Caution: The use of steel wool, although permitting rapid removal of rust, is not recommended. Minute particles of steel wool frequently enter the case and cause harmful internal shorting or grounding of the circuits.

(2) Cover the damaged area and adjacent surface with two coats of enamel, olive-drab, low-gloss, air-drying (stock No. 6G428), or equal, with a suitable brush. Air-dry between applications.

48. Painting and Refinishing

a. GENERAL. When the finish of any of the components of Time Control Equipment RC–133 becomes marred or otherwise damaged, the component must be refinished.

b. TREATMENT. Both wood and metal cases are refinished as follows:

(1) Clean the surface of the case with sandpaper (No. 00 or No. 000). All the finish need not be removed except where the surface film is broken.

(2) Remove the contents of the case and all parts not to be finished.

(3) Spray two coats of enamel, olive-drab, low-gloss, air-drying (stock No. 6G428), or equal, on the case. Air-dry between applications.

49. Emergency Repairs

a. BATTERIES. If the batteries fail, an emergency power supply may be obtained by using the batteries in trucks or other vehicles. Make sure that 12 volts is obtained.

b. TIME INTERVAL APPARATUS EE–85. In case of failure of Time Interval Apparatus EE–85, a time interval signal may be obtained from an adjacent artillery battery. Most cases of breakdown encountered in the time interval apparatus cannot be corrected by an emergency measure that may be taken in the field. In a case where the clock fails to operate, a telegraph key may be connected to the auxiliary contact terminals or in series with the battery and time interval signals, and line connector unit relay terminals. The key can be used to actuate the timing mechanism or the signals, whichever is desired.

c. LINE CONNECTOR UNIT EE–87. As is the case of the time interval apparatus, most cases of trouble encountered in operation of the line connector unit cannot be corrected by any emergency measure that may be taken in the field. If the line connector fails, a signal may be put on the telephone lines by connecting them through a series capacitor directly to the time interval apparatus. If the trouble is located in the relay of the line connector unit, remove the wires connecting the relay terminals, and the time interval apparatus may be removed and attached to the battery terminals after removing the battery wires. Use a small block of wood to block the relay armature in the operated position. When the signal is transmitted from the time interval signal, it will operate the microphone hummers and produce the desired signal.

d. TIME INTERVAL SIGNAL BE–65. If a time interval signal fails to operate and the batteries are found to be good, check the relay. If the relay is inoperative and a signal is reaching the terminal (as indicated by a slight shock at the terminals), the relay winding is open-circuited. Replace the relay with a relay from a telephone switchboard, if available. If no relay is available, a 12-volt horn removed from a truck or other vehicle may be used in place of the time interval signal.

50. Checking Repairs

a. After making repairs, reconnect the repaired component into the system and check for satisfactory operation.

b. Attempt to duplicate the conditions existing during the failure of the component when checking repairs.

51. Unsatisfactory Equipment Report

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel

WAR DEPARTMENT

UNSATISFACTORY EQUIPMENT REPORT

FOR (Technical service) Signal Corps — MATÉRIEL — DATE 3 Dec 44

FROM (Organization) 579 Signal Repair Co. APO 923 (Station) New York, N.Y.

TO (Next superior headquarters) Signal Officer (Station) Ninth Army (Technical service)

COMPLETE MAJOR ITEM

NOMENCLATURE: Time Interval Apparatus EE-85 — TYPE:

MODEL: — MANUFACTURER: John Mitchel Supply Co.

U. S. A. REG. NO.: Order No 1021-P-44 — SERIAL NO.: 2136 — DATE RECEIVED: 12 Nov 44

EQUIPMENT WITH WHICH USED (IF APPLICABLE): Time Control Equipment RC-133

NOMENCLATURE OF DEFECTIVE COMPONENT

PART NO: Sig C stock no 3C1946 — TYPE: Resistor: fixed carbon 270-ohm 2-watt

MANUFACTURER: International Resistor Corporation — DATE INSTALLED: 20 Nov 44

LENGTH OF SERVICE

DATE OF INITIAL TROUBLE: 22 Nov 44

TOTAL TIME INSTALLED — YEARS: — MONTHS: — DAYS: 2

TOTAL PERIOD OF OPERATION BEFORE FAILURE (FILL IN WHERE APPLICABLE)

YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
—	—	2	—	—	—

DESCRIPTION OF TROUBLE AND PROBABLE CAUSE

GIVE TYPE OF FAILURE, MECHANICAL, ELECTRICAL, WORKMANSHIP, MATERIAL, DESIGN

Resistor burned out due to overheating

UNUSUAL SERVICE CONDITIONS

GIVE BRIEF DESCRIPTION

Operation in temperature exceeding 100° F.

TRAINING OR SKILL OF USING PERSONNEL (CHECK ONE): POOR — FAIR — GOOD ✓

DESCRIPTION OF ANY REMEDIAL ACTION TAKEN

Resistor replaced with one of higher wattage rating

RECOMMENDATIONS

Substitution of resistor with 5 watt rating

1ST IND. — ORIGINATING OFFICER

OFFICE — STATION — DATE — SIGNATURE: J. Post

TO CHIEF (Technical service) Signal Officer, Washington 25, D.C. — NAME: J. POST

NAME — RANK AND TITLE: Capt., Sig C

STATION — RANK — ORGANIZATION: 579 Sig Repair Co.

INSTRUCTIONS

1. It is imperative that the Chief of Technical Service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.

2. This form will be used for reporting manufacturing, design or operational defects in matériel with a view to improving and correcting such defects, and for use in recommending modifications of matériel.

3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair, or the issue of parts and equipment. It does not replace currently authorized operational or performance records.

4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (Change No. 3).

5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches or other illustrative material are highly desirable.

6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.

7. This form will be made out by using or service organizations and forwarded in duplicate through command channels to the chief of technical service. The office of the chief of technical service receiving the report will forward an information copy to the Commanding General, Army Ground Forces or Army Air Forces, whichever is applicable, and to the Commanding General, Army Service Forces.

8. Necessity for using this form will be determined by the using or service troops.

W. D., A. G. O. Form No. 468
1 December 1943

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Figure 42. War Department Unsatisfactory Equipment Report.

feel is normal, War Department Unsatisfactory Equipment Report WD AGO Form 468 should be filled out and forwarded

through channels to the Chief Signal Officer, Washington 25, D. C. Refer to TM 37–250 for complete instructions on the handling of this report.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form 54 should be filled out and forwarded through channels. If either form is not available, prepare the data according to the sample form reproduced in figure 42.

APPENDIX I

MAINTENANCE PARTS LIST

1. Maintenance Parts List for Time Control Equipment RC–133

For maintenance parts information, see appropriate sections of Army Service Forces Signal Supply Catalogs Sig–7 RC–133, Organizational Spare Parts, and SIG–8 RC–133, SIG–8 EE–85, SIG–8 EE–87, and SIG 8 BE–65. Higher Echelon Spare Parts.

2. Running Spares Furnished with Time Control Equipment RC–133 (fig. 43)

Signal Corps stock No.	Name of part and description	Quantity
3A23	Battery BA–23	10
3B55	Battery BB–55	2

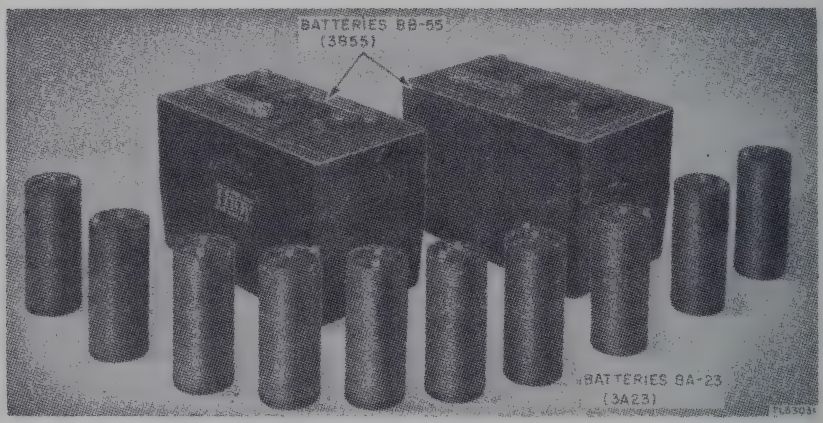

Figure 43. Running spares.

3. Organizational Parts (fig. 44)

Signal Corps stock No.	Name of part and description
3B4294.1 3B4294	Terminal: battery; with wingnut; negative Terminal: battery; with wingnut; positive

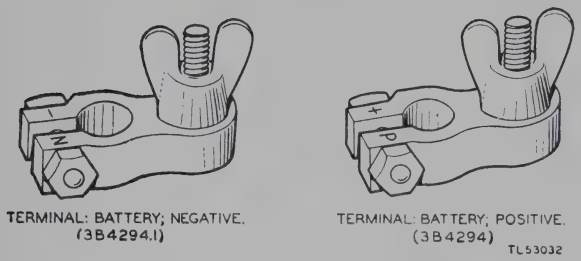

Figure 44. Organizational parts.

4. Third Echelon Maintenance Parts

Fig. ref.	Signal Corps stock No.	Name of part and description
9	4H1187	Line Connector Unit EE–87.
44	3B4294	Terminal, battery with wingnut.
4	4H3085	Time Interval Apparatus EE–85.
11	4H5005	Time Interval Signal BE–65.
43	3B55	Battery BB–55.

APPENDIX II

REFERENCES

1. Technical Manuals on Test Equipment

TM 11–303	Test Set I–56–C, I–56–D, I–56–H, and I–56–J.
TM 11–321	Test Set I–56–E.
TM 11–361	Test Sets EE–65 and EE–65–A through–G.
TM 11–472	Repair and Calibration of Electrical Measuring Instruments.
TM 11–2017	Test Set TS–26/TSM.
TM 11–2613	Voltohmmeter I–166.
TM 11–2626	Test Unit I–176.
TM 11–2627	Tube Tester I–177.

2. Shipping Instructions

U. S. Army Spec. No. 100–14–A	Army-Navy General Specification for Packaging and Packing for Oversea Shipment.

3. Decontamination

TM 3–220	Decontamination.

4. Demolition

TM 5–25	Explosives and Demolition.

5. Camouflage

FM 5–20	Camouflage, Basic Principles.

6. Other Technical Publications

FM 21–6	List of Publications for Training.
FM 21–7	List of Training Films, Film Strips, and Film Bulletins.
FM 21–8	Military Training Aids.
FM 21–40	Defense Against Chemical Attack.

TM 4–320	Mobile Seacoast Artillery, Expert Gunners.
TM 11–430	Batteries for Signal Communications Except those Pertaining to Aircraft.
TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TB SIG 66	Winter Maintenance of Ground Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.

7. Forms

WD AGO Form No. 468	Unsatisfactory Equipment Report.
Air Force Form No. 54	Unsatisfactory Report.

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